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No. 3

THE DIFFERENTIATION OF ORGANIC AND SPASTIC VASCULAR OCCLUSIONS

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THE time-honored classification of intestinal obstruction into mechanic and dynamic occlusions is admirably suitable to peripheral vascular occlusions. Mechanic or organic occlusions obstruct the lumen with a clot, constrict it through a narrowing of the wall or compress it from the outside. Dynamic occlusions may be due to vessel spasm, but also to vessel paralysis, which produces stasis in erythromelalgia. The following classification has been used in our clinic with advantage. (Table I.)

TABLE I

Classification of Peripheral Vascular Occlusions

- (1) Mechanic occlusions
 - Acute { traumatic
 embolic
 - Chronic { degenerative arteriosclerosis
 inflammatory thrombo-angiitis obliterans
- (2) Dynamic occlusions
 - Spastic { Raynaud
 cervical rib or spina bifida
 endocrine disorders
 - Paralytic erythromelalgia

The question, whether an arterial occlusion is organic or spastic in origin, or whether an organic occlusion is aggravated by a superimposed spasm, is of more than academic interest. The differentiation will be a decisive factor in treatment. The following diagnostic procedures have been advocated to differentiate between organic and spastic vascular occlusions.

(1) *Vasomotor Index* (G. E. Brown¹).—Fever is induced with intravenous typhoid vaccine, and the increase in surface temperature of the limb is measured at half-hour intervals with a thermocouple galvanometer. In individuals with normal peripheral blood supply the rise in surface temperature of the toes is much larger than the rise in mouth temperature.
surface temp. — mouth temp.

The vasomotor index = $\frac{\text{surface temp.} - \text{mouth temp.}}{\text{mouth temp.}}$. If the vasomotor

index is 0-1, the increase in the temperature of the skin is double that of the blood; if the vasomotor index is 0, vasodilation is not demonstrable. Brown

uses this test to select patients for sympathectomy. Unless indices of 1.5 and more are obtained, he has not advised an operation of this type.

For lack of suitable facilities one can simplify this test by making the readings with a skin thermometer and taking only one reading about an hour after the chill, which is usually three to four hours after the intravenous injection of twenty-five millions of typhoid bacteria.

Great credit must be given to Brown for emphasizing the vasomotor phenomena in Buerger's disease and devising a method for selecting cases for operation. In our experience, however, the vasomotor index is influenced by factors which cloud the significance of this test. In the first place, the test does not always give identical values on subsequent examinations, and a great deal will depend upon how cold the extremity is when the test is started. Also, the local increase in heat will depend on the activity of the inflammatory process as vessels with more active infection will light up more readily to a foreign protein than vessels in the healed stage. The increase in heat, then, is not merely a peripheral vasodilation but may be an activation of an infected focus.

(2) *Paravertebral Block*.—White² suggested a procaine block of the sympathetic nerves on the upper or lower extremities by paravertebral injections to the first and second dorsal sympathetic ganglia if the upper extremities are tested, and a posterior splanchnic anæsthesia if the lower extremities are tested. Following a successful block the rise in skin temperature is identical with the rise occurring after sympathetic ganglionectomy as the temporary block creates identical conditions with that following the operation. It also imitates the effect of the operation in that pain of sympathetic origin will disappear, and thus demonstrates to the patient what can be expected from the operation.

The objection to this method is that it is far from being simple. As I have stated some years ago, both paravertebral block³ and posterior splanchnic anæsthesia⁴ are fraught with certain dangers and should not be carried out except for very definite limited indications. It is a prerequisite of all diagnostic measures, that they be harmless.

(3) *Spinal Anæsthesia*.—White² but especially Morton⁵ advocate spinal anæsthesia to decide between vascular spasm and occlusion of the lumen or whether a combination of the two exists. Spinal anæsthesia blocks all motor sensory and sympathetic impulses and allows a maximal vascular dilatation. Every surgeon who has repaired inguinal hernias under spinal anæsthesia must have noticed the unusual vascularity of the field.

While a low spinal anæsthesia is relatively safe and simple, I do feel that its use as a diagnostic procedure cannot be advocated as a routine measure. There is a vast difference between using it as an anæsthetic during operation or employing it as a diagnostic test. Furthermore, as White points out, the effect of a sympathectomy, particularly in relation to pain, cannot be judged by this test as all pain tracts to the leg are blocked.

As spinal anæsthesia is admirably suitable as an anæsthesia for lumbar

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sympathectomy, the temperature measurements can be made just previous to the operation and under such conditions the test can easily be carried out. But solely as a diagnostic anaesthesia, which may have to be followed by a second one to perform the operation, its use is not advisable.

(4) *Peripheral Nerve Block*.—It is a well-established fact that the vaso-motor fibres to the vessels run in the peripheral nerves, and are given off to the blood-vessels segmentally. A block of the peripheral nerve, then, should result in an increase in temperature of the innervated limb, because together with motor and sensory nerves, the vasoconstrictors will also be

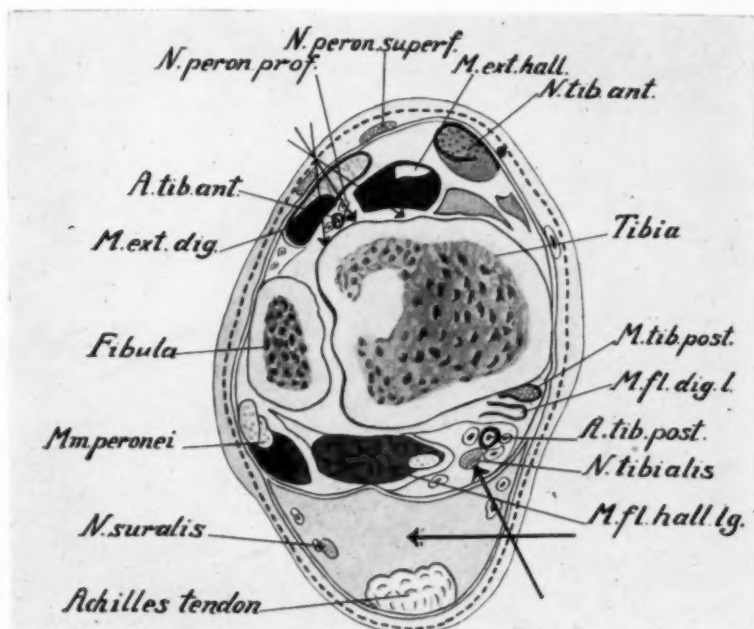


FIG. 1.—Block of the posterior tibial nerve at the internal malleolus. Cross-section of the leg just above the ankle-joint. A wheal is produced with a fine hypodermic needle about 1 centimetre's distance from the Achilles tendon, at the level of the inner malleolus. A fine three-inch needle is now inserted in a postero-anterior direction and pushed forward until it strikes the posterior surface of the internal malleolus. The needle now searches for the nerve and nothing is injected until a definite paræsthesia is signalled in the toes. After careful aspiration for blood, 5 cubic centimetres of 2 per cent. procaine are injected. Anaesthesia of the plantar surface of the foot and toes is complete in ten minutes. (From de Takats, G.: Local Anesthesia. Courtesy of W. B. Saunders and Company, Philadelphia, Pa.)

paralyzed. In describing the block of the brachial plexus, I³ pointed out the hyperæmia and rise in temperature of the arm that appears during a successful anaesthesia. White used the sciatic block in two cases to determine the amount of vessel spasm in the lower extremity.

All the previously described procedures require hospitalization, considerable apparatus and special skill in methods of local anaesthesia. The procedure that I have applied on ambulatory patients needs no equipment except a Tycos skin thermometer, is simple, and requires about fifteen minutes at the utmost. It consists of taking the skin temperature of the big toe on the plantar side, then producing a novocaine block of the posterior

tibial nerve and when complete anæsthesia of the plantar surface of the foot is obtained, another temperature reading is taken at the same area. The readings are usually taken ten minutes after the injection, but occasionally, when the block is not technically perfect, one may have to wait fifteen minutes.

The block of the posterior tibial nerve at the ankle has been described before.³ (Fig. 1.)

The same principle can be carried out on the upper extremity by blocking the ulnar or the median nerves, or, if necessary, the entire wrist, and watching the rise in temperature on the fingers. (Fig. 2.) One can also try to elicit a vascular spasm with a cold bath following a nerve block. If this is not possible, sympathectomy offers good results.

Diagnostic methods to differentiate organic occlusions from vascular

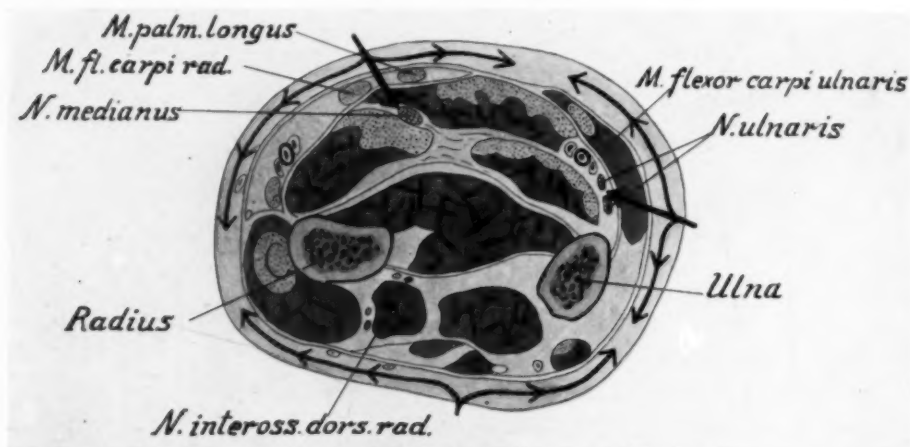


FIG. 2.—Cross-section at the wrist. Block of the median and ulnar nerves and of the deep and superficial branches of the musculospiral nerve. (From de Takats, G.: Local Anesthesia. Courtesy of W. B. Saunders and Company, Philadelphia, Pa.)

spasms will separate three groups of patients. With the help of this simple test, I was also able to find the identical groups in vascular disease, namely:

(a) A complete vasodilation follows nerve block. All changes are due to a vascular spasm. The actual rise in temperature is not as important as the highest reading after nerve block. Thus young individuals may have considerable vasoconstriction in their toes, and may warm up rapidly. This cannot be called pathologic. More important is the level of temperature reached after nerve block. Morton and Scott⁵ call this the "normal vasodilation level," which should exceed 33° C. In our experience it usually reaches 34° or 35° C. Readings below 33° C. are subtracted from this figure and the difference obtained is the "obstruction index." In this first group there is no obstruction index.

(b) No or practically no rise in temperature takes place after nerve block. Old arteriosclerotic and diabetic patients who have an organic occlusion in the vessels show very little or no superimposed spasm. Hence the minimal

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rise in temperature and the high "obstruction index." The average of ten readings on the big toe following block of the posterior tibial nerve was 28° C. thus giving an obstruction index of 5.

(c) There is a certain rise of temperature, but not enough to reach 33° C., Morton's vasodilation level. These are cases of true obstruction with superimposed spasm. This is found mostly in Buerger's disease, but even earlier cases of arteriosclerotic occlusion show it. The amount of vascular spasm will decide whether sympathectomy offers any improvement or not.

The following table summarizes our experience with the posterior tibial block as a test for vascular spasm. (Table II.)

TABLE II
Diagnostic Value of Posterior Tibial Block

	Number of Cases	Average Rise in Temperature	Average Obstruction Index
Group I.....	10	7°C.	None
Group II.....	10	1.5°C.	5
Group III.....	10	4°C.	3

Group I—Patients with cold feet, good pulse, pure spasm, no obstruction. *Group II*—Patients with organic occlusions, no or hardly any superimposed spasm. *Group III*—Patients with organic occlusion and considerable spasm.

Obstruction index (Morton)=normal vasodilation level (33° C.)—maximal temperature obtained after nerve block.

(5) *General Anæsthesia*.—If proper relaxation and depth are obtained, general anæsthesia will abolish the peripheral vasoconstriction. This has been extensively studied by Ipsen in ether anæsthesia and extended by Morton for nitrous oxide and avertin. I have not used this method in our ambulatory patients.

(6) *Diathermy Test*.—When a diathermy current of 1000 to 1500 milliamperes is applied to the lumbosacral region for thirty minutes with one large electrode in front, and another in the back, a very marked rise in temperature takes place on the leg. This temperature was measured above the ankle with a thermocouple galvanometer. A detailed article on our findings in over thirty cases is now being published.⁶ The same three groups of patients can be found, as previously described. Individuals with normal peripheral circulation show a marked rise, and above 33° C. Patients with organic vascular obstruction show no or only an imperceptible rise. Patients with obstruction and some spasm show some rise but do not rise to the normal vasodilation level.

Naturally, the thermocouple needles can be substituted with skin thermometers and thus another simple ambulatory test, which at the same time offers therapeutic possibilities, is at our disposal.

Comment.—I have employed all the described tests, but find that, for

clinical purposes, the peripheral nerve block and the diathermy test are most satisfactory and simple. It is not the purpose of this paper to discuss treatment except to point out that an exact differentiation of the organic and spastic components in obstruction leads to a better understanding of the objects of treatment. While in organic obstruction the aim of therapy consists of (1) increasing collateral circulation, (2) relieving pain, (3) removing dead parts of the limb by amputation, in spastic occlusions the relief from spasm, with physical means, drugs and sympathectomy are logical procedures. Thus these patients are not medical or surgical cases, but individuals suffering from peripheral vascular disease, and combined efforts of group clinics can give them the maximal benefit.

SUMMARY

A simple classification of organic and spastic vascular occlusions is presented. Methods of differentiation with typhoid vaccine, paravertebral block and spinal anaesthesia are described. Two new methods with peripheral nerve block and diathermy are suggested. Both procedures are simple and can be carried out on ambulatory patients. They make for a better understanding and a rational treatment of peripheral vascular disease.

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COMPRESSION OF THE LUMBOSACRAL ROOTS OF THE SPINAL CORD BY THICKENED LIGAMENTA FLAVA

BY EDWARD BANCROFT TOWNE, M.D.

AND

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HYPERTROPHY of the ligamenta flava in the lumbar region as a cause for compression of the cauda equina is a clinical entity hitherto not described. Two patients recently observed had spontaneous pain in the back and legs, progressive flaccid paralysis, fibrillary twitching of the muscles, sacral anaesthesia and absent Achilles reflexes. In addition, one had xanthochromic spinal fluid, and the other had disturbed function of the vesical and anal sphincters. In each instance a complete block in the circulation of the cerebrospinal fluid was demonstrated by lipiodol injection, and the convex or pointed lower end of the opaque shadows suggested an extradural lesion. This impression was verified at operation, which revealed thickening of several ligamenta flava, most marked at the level demonstrated by the lipiodol. Excision of the hypertrophic ligaments relieved the block in the circulation of the cerebrospinal fluid. The fact that these two cases were observed during a period of

ten months would suggest that the condition is not excessively rare, but a review of the medical literature has failed to disclose another example.

Anatomy.—The ligamenta flava or subflava stretch across the posterolateral aspect of the spinal canal between the laminae. (Fig. 1.) The ligaments, which are made up of yellow elastic fibres, are attached to the anterior aspect of the superior laminae and to the posterior aspect of the inferior. The two ligaments of each interlaminar space fuse in the mid-line, and extend laterally to form the posterior margin of the intervertebral foramina. (Fig.

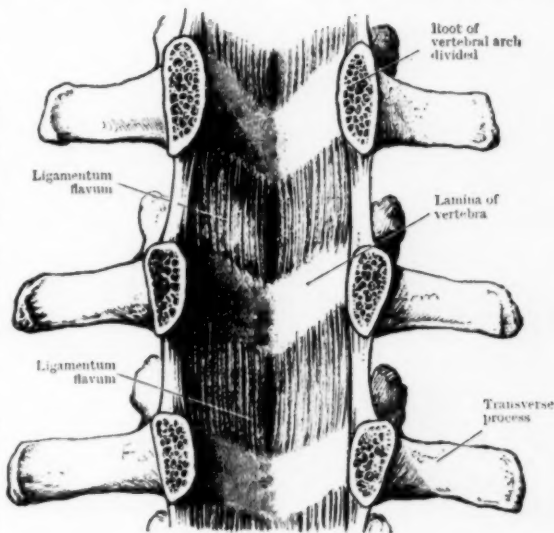


FIG. 1.—Ligamenta flava as seen from the front after removal of the bodies of the vertebrae by sawing through the roots of the vertebral arches. From Cunningham's Anatomy, Wm. Wood & Co., N. Y., 1918.

2.) The normal ligament, as observed during a laminectomy, is one or two millimetres thick and distinctly yellow in color.

CASE I.—(E. B. Towne.) *Compression of the cauda equina by thickened ligamenta flava, causing flaccid paralysis of right lower extremity. Restoration of normal function after removal of thickened ligaments.*

S. S., a Portuguese laborer, aged fifty-three years, was admitted to the Southern Pacific General Hospital October 19, 1929, complaining of pain and weakness in the right leg.

Past History.—He was born in Portugal and had always done heavy manual labor. He had had pneumonia, malaria, gonorrhœa and syphilis, and the last had been treated by intravenous injections. There had been intermittent discharge of pus from both ears for many years, frequent head colds, occasional sore throats, and painful urination with recent difficulty in starting the stream. Otherwise, the past history was negative. He could remember no injury to the back. He used a moderate amount of wine and smoked very little. His wife and six children were alive; one boy aged sixteen was mentally

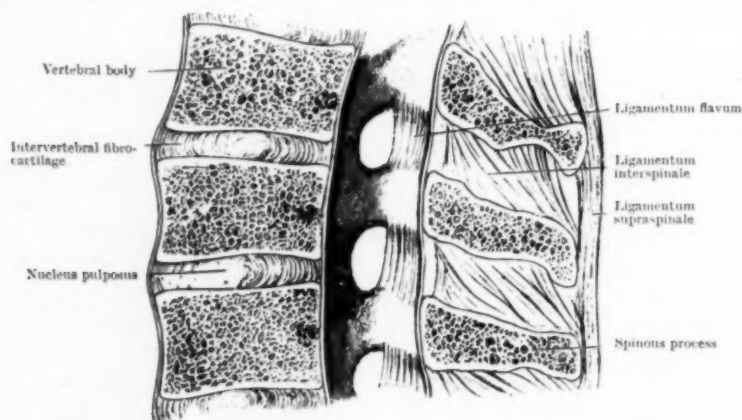


FIG. 2.—Median section through a portion of the lumbar part of the vertebral column. From Cunningham's Anatomy, Wm. Wood & Co., N. Y., 1918.

defective and was a ward of the Juvenile Court, but the other children were mentally and physically normal.

Present Illness.—About five or six weeks before admission he began to have pain in the right lumbar and sacral regions, which soon extended down the back of the right thigh and leg. The pain was always made worse by motion and relieved by rest, and it gradually became more severe. Shortly after the onset of the pain, he noticed a progressive weakness and numbness of the right leg. For a week before admission the pain had been very severe, and weakness had increased so that he could walk only with the help of a cane.

Physical Examination.—The patient was a poorly developed and poorly nourished man, 5 feet, 6 inches tall, weighing 130 pounds. Temperature was 98.6°, pulse rate 82, respiratory rate 18, blood pressure 164/90. Except for the following findings, general physical examination showed nothing abnormal. The mouth showed advanced pyorrhœa and numerous decayed teeth, and the tonsils were enlarged and hyperæmic. The tympanic membranes were perforated, and there was scanty, purulent discharge in both auditory canals.

The cranial nerves showed no abnormality. Motor power, sensation and reflexes were normal in the arms. The abdominal and cremaster reflexes were present. There was no motor loss in the abdominal muscles, and sensation was normal down to the first lumbar segment. The vesical and anal sphincters functioned normally.

COMPRESSION LUMBOSACRAL ROOTS OF CORD

All muscles of the right thigh and leg showed occasional fibrillary twitchings. Muscle tone was decreased in the right lower extremity, and there was considerable atrophy, the circumference of the right thigh and leg being about 2 centimetres less than at corresponding levels on the left. All muscle groups of the right lower extremity were weak, but he was able to walk with a cane, throwing out the leg and scuffing the toe. The loss of power progressed rapidly, so that after two weeks all motions of the right lower extremity were absent except for weak flexion of the leg and weak plantar flexion of the foot. Sensation was diminished, and in places almost totally absent, over the distribution of the third lumbar to the second sacral segments inclusive on the right side. No loss could be detected in third, fourth or fifth sacral fields on the right. No motor or sensory changes were ever found in the left lower extremity. The right patellar reflex was at first sluggish and later absent. The left patellar reflex was active. The



FIG. 3.—Case I. Röntgenogram showing blockage of the lipiodol just above the lower margin of the body of the second lumbar vertebra.



FIG. 4.—Case I. Röntgenogram showing the convexity of the lower margin of the lipiodol, suggestive of an extradural lesion.

right Achilles reflex was absent, the left active. The plantar reflex was normal on both sides.

Röntgenograms of the lumbosacral spine showed hypertrophic osteoarthritis. There were six lumbar vertebrae. Urinalysis and blood count were normal. The Wassermann reaction on the blood was negative. Spinal puncture: the fluid was xanthochromic, the pressure was not recorded, and Queckenstedt's test was not done. Wassermann reaction was negative, no leucocytes, 34 red blood-cells, globulin + + +, colloidal gold (44 54 32 22 33).

The preliminary diagnosis on the medical service was sciatica due to osteoarthritis of the spine. After the report on the spinal fluid, November 7, the patient was referred to the neurosurgical service with the diagnosis of tumor of the cauda equina. November 12, lipiodol was introduced into the subarachnoid space at the cisterna magna, and the

films showed that it was held up just above the lower margin of the body of the second lumbar vertebra (Fig. 3), and that no lipiodol had passed this point after twenty-four hours. In contrast to the concave cap usually seen above an intradural tumor, the lower margin of the lipiodol showed a convexity in the posterior projection (Fig 4), which led to a pre-operative diagnosis of possible extradural tumor.

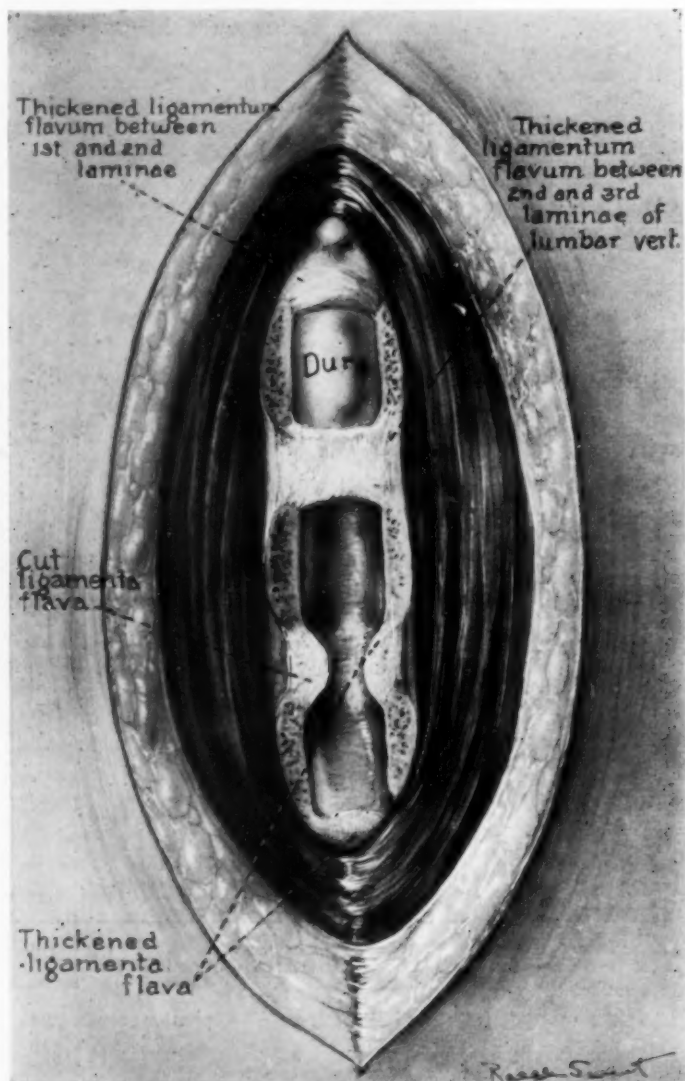


FIG. 5.—Case I. Diagrammatic sketch of the thickened ligamenta flava which compressed the roots of the spinal cord, as exposed by laminectomy.

Operation.—November 14. A laminectomy was done on second, third and fourth lumbar vertebrae. After excision of the spinous processes, dense masses of fibrous tissue bulged up between the exposed laminae. These masses were not disturbed, though they made removal of the laminae unusually difficult. The picture after laminectomy is shown semidiagrammatically in Fig. 5. There was no epidural fat, and the dura was so thin that it was almost transparent. The dura opposite the second lumbar laminae was bulging

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and pulsating, but that opposite third and fourth laminae was partly collapsed, and was not pulsating. On compression of the jugular veins, the dura opposite third and fourth laminae did not fill. Aspiration opposite the second laminae gave clear fluid containing lipiodol, and aspiration opposite the third laminae gave a few drops of yellow fluid, containing no lipiodol. The block was clearly due to the band of tissue which crossed the dura between the laminae of second and third vertebrae in the normal position of the ligamenta flava. This band was divided down to the dura. It was 7 or 8 millimetres thick, and this thickening extended laterally, so that the dura was constricted to about one third or one fourth of its normal diameter. The inner aspect of the band was smooth, and it was not attached to the dura. When the tissue had been removed, fluid flowed past and filled the dura opposite the third and fourth laminae. The cut surface of the band was yellowish white and of a very firm consistency. The thickened ligament was excised as far laterally as possible. To a less degree, there was similar thickening of the ligaments between first and second, third and fourth, and fourth and fifth laminae which constricted the dura at these points. These were also excised. Lipiodol was now obtained by aspiration opposite the fourth laminae. The block in the circulation of the

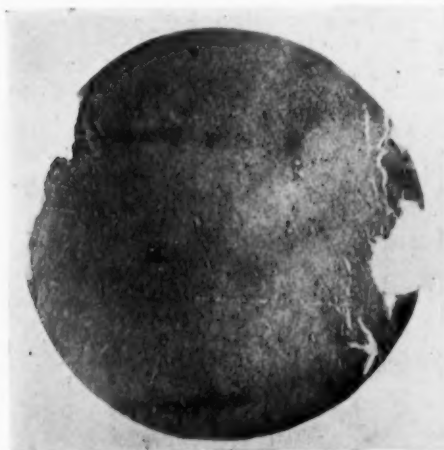


FIG. 6.—Case I. Microscopic section (hematoxylin and eosin) of hypertrophied ligamenta flava, identical in appearance with section of normal ligamenta flava. (Mag. 67 x.)



FIG. 7.—Case I. Microscopic section of thickened ligamenta flava stained by Unna's orcein method to show the elastic fibrils. (Mag. 67 x.)

cerebrospinal fluid had been removed, but it was difficult to account for the motor and sensory loss, limited to the right lower extremity, on a basis of concentric constriction of the cauda equina. To rule out a possible intradural lesion, the dura was opened. The nerve roots were slightly hyperæmic, and there was no tumor. The roots were dissected at mid-line and retracted laterally, disclosing a slight ridge, raised perhaps 2 millimetres, along the line of each exposed intervertebral disc. The dura was so fragile that sutures would not hold, so it was left open, and the soft parts were closed.

Two weeks after operation the loss of sensation in the right lower extremity had completely disappeared, and motor power was rapidly improving. December 18, 1929, in the fifth post-operative week, the muscle groups of the right thigh and leg were almost as strong as those of the left, and the patient could walk more than a mile with normal gait and little fatigue. The patellar and Achilles reflexes were active and equal. In March, 1931, sixteen months after operation, reëxamination showed no motor or sensory loss, and the reflexes were normal.

Microscopic sections, stained by hematoxylin and eosin, showed dense fibrous tissue with comparatively few cells. (Fig. 6.) In sections stained by the Van Gieson method, it was seen that only a small proportion of the intercellular substance was collagen. Most

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of the fibrous tissue was made up of elastic fibrils, as demonstrated by sections stained by Unna's orcein method (Fig. 7), in which the rather broad, wavy fibrils were stained a light brown color.

CASE II.—(F. L. Reichert.) *Compression of the cauda equina by thickened and partly calcified ligamenta flava, causing flaccid paraplegia. Rapid improvement after removal of thickened ligaments.*

Mrs. C. E., an American housewife, aged thirty-two years, was admitted to Lane Hospital August 24, 1930, complaining of pain in the back and legs, and of inability to walk.

Past History.—There had been no previous illnesses except measles and mumps, acute otitis media at the age of twelve years, and headaches with nausea and vomiting



FIG. 8.



FIG. 9.

FIG. 8.—Case II. Röntgenogram showing blockade of lipiodol at the fourth lumbar vertebra.

FIG. 9.—Case II. Röntgenogram showing the tapered outline of the lipiodol at the level of the lower third of the fourth lumbar vertebra.

once or twice a month since the age of fourteen years. There was no history of injury to the back. She had been married thirteen years, and had one child, aged twelve years. There had been no further pregnancies.

Present Illness.—She had always had a "weak back," with occasional backaches. Seven years previous she had had an attack of severe pain in the lower lumbar spine, with weakness of the legs. It was difficult to arise from a chair and to walk, and she stayed in bed for a month. Three similar attacks incapacitated her, four to eight weeks at a time, during the next six years. Between attacks the legs were practically normal, but she always suffered with backache when fatigued. The fifth attack began in October, 1929, ten months before admission, with pain in the lumbar spine, followed shortly thereafter by pain down the right thigh and leg, and weakness of the right lower extrem-

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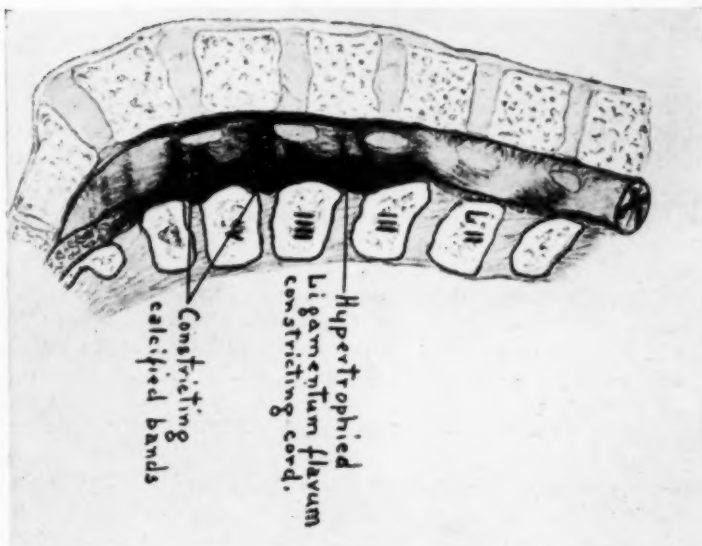


FIG. 10.—Case II. The thick, longitudinal ligamentous structure which surrounded and compressed the dura.

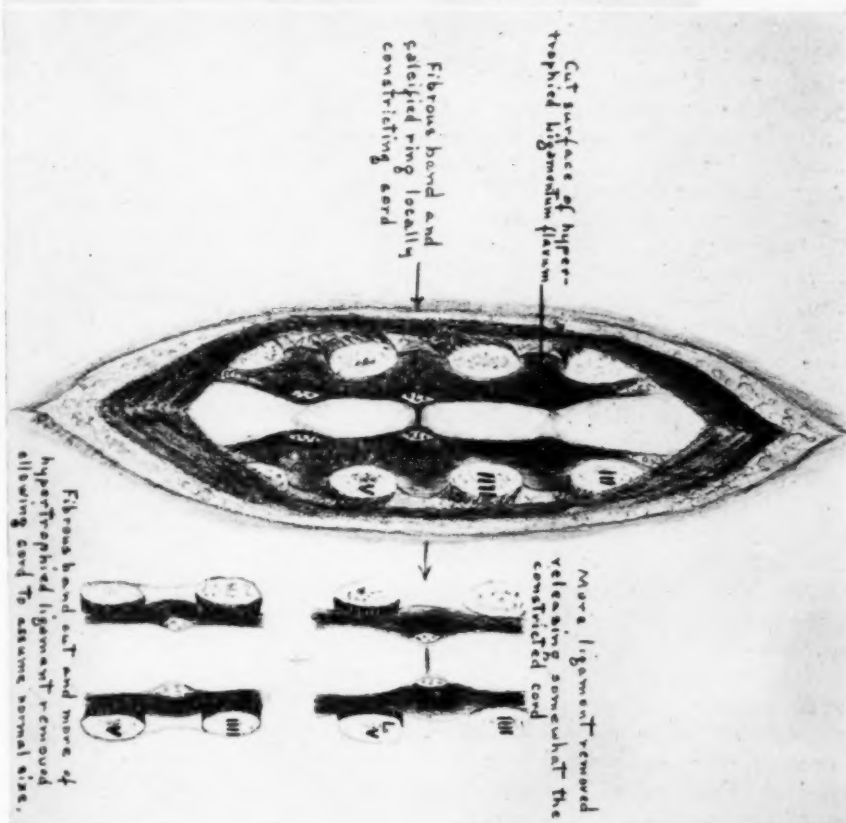


FIG. 11.—Case II. In two of the localized thickenings of the longitudinal ligamentous structure a ring of bone was incorporated. Beneath the ring of ligament and bone at the fourth interspace a fibrous band further constricted the dura.

ity. After some weeks the left lower extremity was similarly involved. In January, 1930, she became bed-ridden. In April, 1930, she noticed numbness of the feet and legs. In July, six weeks before admission, the lower extremities had lost practically all motion, and she began to have difficulty in voiding, which gradually progressed to complete retention one week before admission.

Physical Examination.—A well-developed, rather obese woman lying on her right side with hips and knees flexed. Temperature was 98.8°, pulse rate 80, respiratory rate 20, blood pressure 140/92. The cranial nerves were negative, and motor power, sensation and reflexes were normal in the upper extremities. There was pain on pressure over the lower lumbar spinous processes. The bladder was distended, and the tone of the anal sphincter was poor.

Fibrillary twitchings were seen in the muscles of the lower extremities, and there was muscular atrophy, more marked on the left. Resistance to movements of both lower extremities was hardly perceptible. All muscle groups were flaccid and weak, with very slight voluntary motion at all joints. The patient cooperated poorly in the examination of sensation, so that, although she complained of subjective numbness of the legs and feet, it was possible to map out only a partial saddle anaesthesia. The patellar reflexes were active and equal. The Achilles reflexes were absent. The plantar reflexes were normal.

Röntgenograms of the lumbosacral spine were normal. Spinal puncture in the third interspace gave no fluid. The fluid obtained from the second interspace was slightly bloody, pressure 18 centimetres of water. Queckenstedt's test was negative. Wassermann reaction was negative, colloidal gold (22 23 21 10 00). August 29, lipiodol was introduced into the subarachnoid space at the cisterna magna, and the films showed that it stopped at the level of the fourth lumbar vertebra, (Fig. 8), and that no lipiodol had passed this point three days later. In the lateral projection (Fig. 9), the lower margin of the lipiodol formed a sharp point at the level of the lower third of the body of the fourth lumbar vertebra. The patient was transferred to the surgical service with the diagnosis of tumor of the cauda equina.

Operation.—September 4. A laminectomy was done on the third, fourth and fifth lumbar, and part of the first sacral vertebrae. The normal epidural fat was not encountered when the arches of these vertebrae were removed. A thick, longitudinal ligamentous structure surrounded the dura and compressed it, as shown diagrammatically in Fig. 10. When the posterior portion of the ligament was removed, it was seen that the underlying dura, considerably thinned, was further constricted in the spaces between the laminae by localized thickenings in the ligamentous structure. (Fig. 11.) In the fourth and fifth interspaces, a ring of bone was incorporated in the thickened ligament. Beneath the ring of ligament and bone at the fourth interspace, there was a fibrous band which further constricted the dura. This was the site of the block in the cerebrospinal fluid circulation, as shown by the absence of pulsation below the fourth interspace. The inner surface of the ligamentous structure was smooth and glistening and was not attached to the dura. After removal of all constricting tissue, the dural sac resumed its normal size, and pulsations appeared below the fourth interspace. Exploration above the third lumbar and below the first sacral laminae showed that a dural sac of normal size was covered with epidural fat. The dura was not opened, and the wound was closed in layers.

On the seventh day after operation there was considerably improved motor power in the lower extremities. On the twenty-first day the patient could stand on her legs and walk with support. She began to void spontaneously on the seventeenth day. When she was dismissed, on the twenty-fourth day, the saddle anaesthesia was unchanged. She reported for reexamination January 6, 1931, four months after operation. She was able to walk without a cane. Motions of the right ankle and toes were not as strong as those of the left. Sacral anaesthesia was still present on the right, but was now absent on the left, except in the fourth and fifth sacral segments. There was no disturbance of the

COMPRESSION LUMBOSACRAL ROOTS OF CORD

sphincters. April 14, 1931, the patient wrote that the left lower extremity was normal, and that the right was still improving.

Microscopic Examination.—The fibrous portion of the specimen was exactly like that from Case I. Fig. 12 presents the picture with hematoxylin eosin stain. The intercellular substance showed a preponderance of elastic fibres, with a few collagen fibres. Sections of the partly calcified portion showed normal bone, which was surrounded by a zone of homogeneous tissue containing cartilage cells. (Fig. 13.) Adjoining this cartilaginous tissue was the typical dense elastic tissue which made up the bulk of the specimen.

Discussion.—The pathological condition in the first case was unmistakable. The ligamenta flava were markedly thickened, and one pair of them had blocked the circulation of the cerebrospinal fluid. There was no extension of the process between adjacent ligaments, the dura being in direct contact with the laminæ. The thickened ligaments were not attached to the underlying

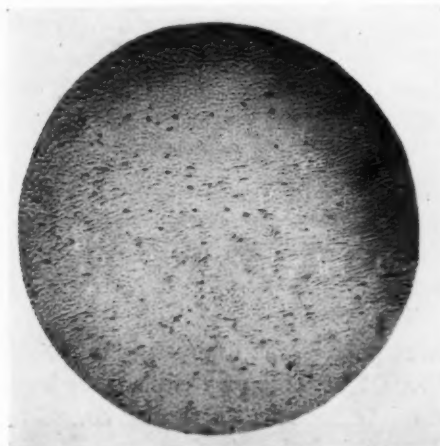


FIG. 12.



FIG. 13.

FIG. 12.—Case II. Microscopic section stained with hematoxylin and eosin. (Mag. 67 x.)

FIG. 13.—Case II. Microscopic section (hematoxylin and eosin) taken from region of the calcified ring in the ligamenta flava, showing normal bone surrounded by a zone of homogenous tissue containing cartilage cells. (Mag. 67 x.)

dura. The condition found at operation in the second case was more advanced and complicated. The greatest thickening was at the normal sites of the ligamenta flava, and here were the oldest parts of the lesion, as shown by the rings of calcification at these points. However, the proliferation of the ligamenta flava had extended upward and downward, completely ensheathing the dura, with the thinnest portions of the process under the middle of the laminæ. Although the picture, as first exposed, might have suggested an external pachymeningitis, this diagnosis was readily ruled out as the operation proceeded and showed that the extradural mass was entirely separate from the dura, and that its thickest portions were between the laminæ.

Microscopically, the specimens removed in both cases showed yellow elastic tissue, in no way distinguishable from sections of normal ligamenta flava, except that, in Case II, bone had been deposited in the thickest and

probably the oldest portions of the hypertrophied ligaments. None of the sections showed either tumor formation or inflammatory process.

The etiology of the condition is obscure. The first patient gave a history of a supposed chancre, but the Wassermann reactions on the blood and spinal fluid were negative. In the second case, there was no history of syphilis, and the Wassermann reactions were negative. The first patient had many foci of infection, in the teeth, tonsils and middle ears, and he had an advanced osteoarthritis of the spine; but the second was free from obvious foci, and the röntgenograms of her spine showed only a few hypertrophic fringes in the lumbar vertebræ. Certainly the condition here described is in no way analogous to the compression of the spinal cord and its roots by osteoarthritis, as described by Bailey and Casamajor.¹ Neither patient gave a history of trauma to the back, and although the first, being a laboring man, may well have had repeated mild injuries, the second patient at the time of onset of symptoms was a woman twenty-five years old, in whom unrecognized trauma seems most unlikely.

The diagnosis of compression of the cauda equina was made without difficulty on the history and physical findings in each case. The lipiodol examinations offered a suggestion, in the shape and position of the shadows, that the lesion might be extradural, but there was no pre-operative suspicion of the true character of the lesion. The history of the second patient was unusual in that she had passed through four transient attacks of paraplegia before the final one which did not clear up. The first of these episodes occurred seven years before she came under observation, and the lower extremities were apparently normal between attacks. It is interesting to speculate whether the elastic tissue of the thickened ligaments may explain the long remissions, and whether the first patient might have had a similar course if he had not been operated on during his first attack, before both lower extremities were involved.

Summary.—A new cause of compression of the lumbosacral roots of the spinal cord is reported, with two illustrative case histories. The condition is a proliferation of the ligamenta flava between laminæ of the lumbar spine, which eventually causes a block in the cerebrospinal fluid circulation and compression of the cauda equina. The etiology is unknown. The pathological process is a simple hypertrophy of the ligamenta flava. Extradural compression may be suspected from the position and shape of the lipiodol shadows. The symptoms of compression of the cauda equina were cured by surgical removal of the thickened ligaments.

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FRACTURES OF THE UPPER JAW AND MALAR BONE

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FRACTURES OF THE MAXILLA

FRACTURES of the maxilla are much less common than those of the mandible, although they are being seen with increasing frequency, because of automobile accidents. They are often associated with extensive head injuries, fracture of the base or the vault of the skull, and of other facial bones, such as the malar, nasal, and frontal, as well as the mandible. Owing to the absence of powerful muscle attachments to the maxilla, displacement of fragments is not due to muscular pull, but to the direction of the traumatizing force and sometimes to gravity.

Classification.—Most fractures of the maxilla fall under the following



FIG. 1.

FIG. 1.—Unilateral fracture of maxilla, showing downward displacement.

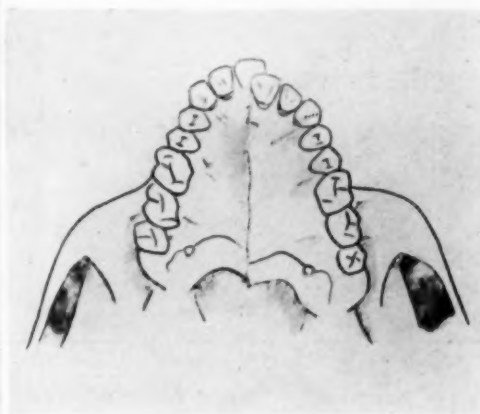


FIG. 2.

FIG. 2.—Unilateral fracture of maxilla, showing overlapping at media palatal suture.

heads: (1) Fracture of the alveolar process alone; (2) unilateral fracture across the facial aspect above the roots of the teeth, and through the hard palate; (3) bilateral horizontal fracture above the palate and below the orbital plates; (4) Extensive comminution and crushing of the upper part of the maxillæ, complicated by fracture of the nasal and other bones.

(1) Fracture of the alveolar process alone may occur in the extraction of teeth. The tuberosity is occasionally fractured in extraction of the third molar. A blunt localized force, such as by a thick stick against the teeth, may result in this type of fracture. In addition to the break in the bone, tooth

* Read before the Philadelphia Academy of Surgery, March 2, 1931.

roots may be fractured, or teeth may be broken off. There is usually more or less displacement of the fragment, with mal-occlusion of the teeth, and gentle manipulation of the teeth will reveal mobility of the loosened fragment. The X-ray is useful in indicating the extent of the fracture, and also involvement of tooth roots.

Treatment.—Any hopelessly detached and fractured teeth and roots should be removed. If the fragment of alveolar process is covered by and attached to overlying gum tissue, it is often possible to obtain union by a half-round arch wire fastened to teeth in the fragment and to those of the sound portion of the jaw; or the teeth in a sound portion of the maxilla can be fixed in occlusion with corresponding mandibular teeth by means of wires. If the fragment is exposed by detachment of overlying soft tissue, it is generally

necessary to remove it as necrosis will almost certainly occur. The technic of application of ligature wires and arches to the teeth is the same as for fixation of fractures of the mandible and has been fully described in previous papers.⁵



FIG. 3.

FIG. 3.—Treatment of unilateral fracture of maxilla by wiring maxillary and mandibular teeth on sound side.

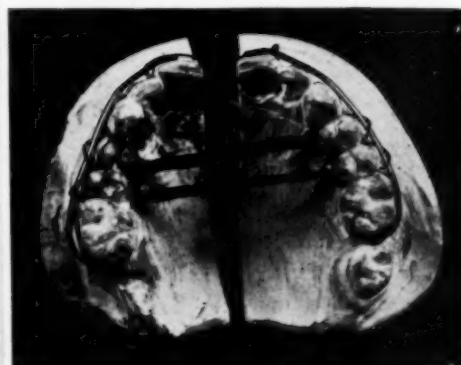


FIG. 4.

FIG. 4.—Fracture through median palatal suture. Two sides brought together by elastic force across palate.

(2) Unilateral fracture of the maxilla is usually caused by direct force coming from in front or from one side. In addition to the symptoms of contusion of the side of the face, the entire maxillary dental arch on the side affected is usually depressed (Fig. 1), and may be forced inward, causing a thickening of the palate due to overlapping at the palatine suture (Fig. 2). Occasionally, the fragment will be forced outward, causing a spreading of the dental arch on that side. By gentle manipulation, mobility of the fragment can be readily detected. X-ray examination is useful in determining the extent of the fracture, relationship of teeth, etc. The maxillary sinus may be filled with blood clot which usually undergoes absorption or disintegration without symptoms, but which may become infected.

FRACTURES OF UPPER JAW

Treatment.—Many cases can be successfully treated by pushing the fragment back in place until the teeth are in occlusion and then wiring the teeth of the sound side of the maxilla to those of the mandible (Fig. 3).

Immediate complete reduction with restoration of normal occlusion of the teeth may not be possible. With displacement of the teeth toward the median line, gradual spreading of the dental arch may be necessary, by means of jack-screw force across the palate. When the teeth have reached a satisfactory occlusal relationship the upper and lower dental arches may be ligated together with brass wires.

Where the maxillary fragment is displaced outward, the dental arch may be narrowed by elastic bands running transversely or diagonally across the palate, being attached on each side to a half-round wire arch on the teeth. One of these arches is molded to fit the vestibular surfaces of the teeth on each side. The ends of the brass wire ligatures attaching each arch to the teeth are twisted on the palatal side of the teeth to form hooks, which afford attachments for the elastic bands (Fig. 4). In case of maxillary-sinus infection complicating the fracture, this will require appropriate treatment.

(3) Bilateral horizontal fracture of the maxilla is usually caused by direct force from in front, such as by striking the steering wheel of a suddenly arrested automobile. In the majority of cases the entire maxilla is displaced backward and downward (Fig. 5). The fracture may extend back through the pterygoid processes. The entire dental arch can be moved as a unit. The hard palate may be intact, or the case may be complicated by a longitudinal median fracture through the palate with either spreading or narrowing of the dental arch. Here again, symptoms of maxillary-sinus infection may become manifest.

Treatment.—In bilateral fracture of the maxilla above the palate, fixation by means of the mandibular teeth is not advisable at first, because of the movability of the lower jaw. Support here should be obtained from the cranium by means of a head apparatus and reversed Kingsley splint, as described by Marshall.⁶ The Marshall apparatus consists of a vulcanite or metal-cap splint made to fit the upper teeth; from the outer sides of the splint heavy metal



FIG. 5.—Bilateral horizontal fracture of maxilla, showing downward displacement.

bars emerge at the corners of the mouth and curve back for a distance over the cheeks. A plaster-of-Paris skull cap is made, in which are embedded straps or hooks which can be connected with the bars emerging from the mouth to make traction in the desired direction. When reduction has been attained, as determined by the relationship of the lower to the upper teeth, the latter are fastened in occlusion with wires until consolidation is complete. We have had useful service in cases of this kind from an emergency apparatus consisting essentially of a metal impression tray to which heavy wire arms are soldered on each side for attachment to the head cap (Fig. 6). This tray is secured to the teeth by dental impression compound and two or three ligature wires, thus avoiding the necessity of taking impressions and making special splints. Another emergency apparatus consists of a heavy arch bar to be secured to the vestibular surfaces of the teeth with wire ligatures and provided with arms extending out of the mouth on each side for attachment to the head cap (Fig. 7). This and the apparatus shown in Fig. 6 were made by



FIG. 6.

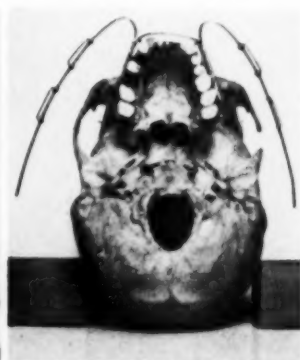


FIG. 7.

FIG. 6.—Metal tray with arms extending out of mouth for attachment to head cap. (Made by Dr. E. Howell Smith.)

FIG. 7.—Author's arch bar secured to teeth by wire ligatures, for treatment of fracture of maxilla in connection with head cap. (Made by Dr. E. Howell Smith.)

Dr. E. Howell Smith. They can be made in two or three sizes and kept on hand so as to be immediately applicable in any case when the need arises. Where these cases are complicated by fracture through the hard palate, additional measures must be taken to correct the lateral displacement as described under Group I. About six weeks is the average time for union to take place in these fractures.

The following case illustrates the application of these principles:

M. D., female, aged twenty-one, single, was struck down by an automobile while walking across the street, being rendered unconscious by head injuries. She received emergency treatment at St. Luke's Hospital, Bethlehem, Pa., by Dr. W. D. Chase. Three days later she was brought to the Graduate Hospital, Philadelphia. Here, the patient's face was found to be greatly swollen and battered, the eyelids being practically closed. There was a deep transverse gash across the bridge of the nose with wide separation of its edges. The nasal bones had been detached from the frontal bone above and driven over with the nasal process of the right maxilla into the right orbit, with extensive comminution. The nasal articulation of the frontal bone was exposed in the wound. The external

FRACTURES OF UPPER JAW



FIG. 8.—Skull showing attachment of wire passed around nasal process of maxilla to teeth of opposite side. (Blair.)



FIG. 9.—Röntgenogram showing wire looped around nasal process of maxilla and fastened to teeth on opposite side of upper jaw.

part of the nose below the wound was sagging downward and in a flattened condition due to lateral displacement of the septum. The patient complained of mal-occlusion of the teeth and examination showed the entire maxillary dental arch to be displaced somewhat backward and downward and slightly movable as a whole. This indicated a bilateral transverse fracture of the maxilla.

Very little suppuration was present in the nasal wound, the temperature was slightly elevated, and the general condition of the patient was good. Owing to the severity and extent of the injury it was considered advisable first to attempt correction of the displacement of the bones about the nasal wound, under ether anaesthesia. It was necessary to remove some of the comminuted nasal-bone fragments. The portion which, together with the nasal process of the maxilla, had been driven into the right orbit could be lifted over into fairly good position, but difficulty was experienced in retaining it, so that the plan advocated by Blair¹ (Fig. 8) was employed. A small incision was made just mesially to and below the inner canthus of the right eye, exposing the loose bone fragment. A piece of soft brass wire, 24 gauge, was carried down through the incision by means of a heavy curved needle, across the nasal cavity, transfixing the cartilaginous septum, to emerge through the mucous membrane of the vestibule of the opposite side of the mouth. The other end of the wire was then threaded through the needle and passed around the



FIG. 10.

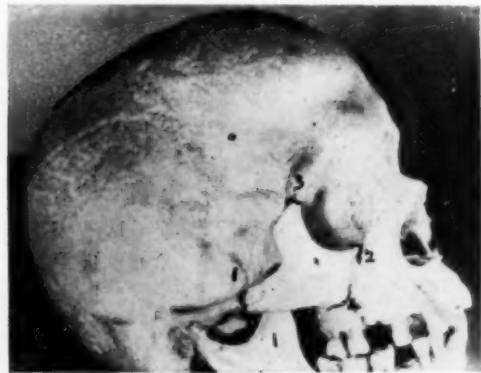


FIG. 11.

FIG. 10.—Bilateral horizontal fracture of maxilla. Profile view with apparatus in place.
FIG. 11.—Skull showing principal sites of fracture of malar bone: (1) Zygoma. (2) Infra-orbital foramen region. (3) Frontal process. (4) Maxillo-malar articulation.

loose bone fragment, being in turn brought down in the same manner into the vestibule of the mouth. The displaced bone fragment was then firmly anchored in position by attaching the ends of the wire to the canine and first pre-molar teeth of the left maxilla. (Fig. 9.) The retracted edges of the irregular skin wound were undermined, and almost completely approximated by sutures. Vaseline gauze packs were inserted into each nasal chamber for twenty-four hours. The complication chiefly to be feared was meningitis, but the temperature returned to normal after three days, both the accidental wound and the small operative incision healed satisfactorily, and the swelling of the soft tissues gradually subsided. Five days later, attention was given to the maxillary fracture. The heavy wire-arch appliance shown in Fig. 7 was ligated to the upper teeth, and a plaster head cap was applied. With light leather straps traction was then made possible on the maxilla (Fig. 10), and in a few days the normal occlusion of the teeth was re-established. Sufficient stability of the upper jaw was noted after three weeks and the appliances were removed. Six weeks after insertion the brass wire around the nasal fragment was removed under local anaesthesia. Respiration through the nose was found to be free, and the scar of the accidental wound was becoming much less noticeable. Later improvement in the nasal profile is contemplated by implantation of costal cartilage.

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(4) Bilateral fracture with extensive comminution and crushing of the upper part of the face. This sometimes occurs as the result of a gunshot wound or a very severe trauma from below, forcing the maxilla up and back into the more fragile bones above. The maxilla loses all support from the base of the skull, which itself is frequently fractured also. Infection from the nasal fossa and sinuses is a common complication, and meningitis is not unusual.

Treatment.—The general condition of the patient must always be considered first. Too strenuous attempts at replacing the bone may result in opening up avenues of infection to the meninges. Before attempting reduction it is best to wait, at least a few days, until the general condition of the patient has improved. Drainage from involved nasal accessory sinuses should be provided, preferably through the mouth and nose, and cleansing maintained by frequent irrigation.

Means of Fixation.—In many cases of this character upward pressure against the skull cannot be employed since the normal length of the face would not be preserved. A metal or vulcanite splint is made for the maxillary teeth, with bars extending on each side from the corners of the mouth, but instead of making upward pressure with straps, the dental splint must be suspended rigidly at the proper distance from the skull cap by means of solid vertical bars or rods.

FRACTURES OF THE MALAR BONE AND ZYGOMATIC ARCH

Fracture of the malar bone may accompany a fracture of the maxilla or mandible, or it may occur alone. The best description of this injury is given in a recent article by Gillies, Kilner and Stone.⁴ It is always due to direct violence, from a kick, blow or fall. The fractures occur at or near the lines of suture of the malar bone with the surrounding bones, *viz.*, at the zygomatic arch, the infra-orbital foramen region and lower border of the orbit, the frontal process, and the articulation with the maxilla (Fig. 11). The body of the malar bone is usually driven into the maxillary sinus and impacted there.

Diagnosis.—Gillies, Kilner and Stone call attention to a definite flattening of the cheek in its upper part and fullness in its lower (Fig. 12). The early swelling masks the depression of the cheek bone, so that the injury is frequently overlooked. Palpation reveals irregularities and tenderness at the points of fracture—over the zygoma, the outer and lower borders of the orbit, and high up in the buccal sulcus in the mouth. Usually crepitus cannot be elicited as the fractured bone is impacted. Bleeding from the nose and subconjunctival ecchymosis on the side of the injury are usually noted. Numbness of the skin over the distribution of the infra-orbital nerve is practically always present. Movements of the lower jaw may be interfered with from pressure of the depressed bone against the coronoid process, and we have recently seen a case in which the coronoid process of the mandible was also fractured. Marked depression of the malar fragment may result in diplopia. Maxillary-sinus infection may follow, due to laceration of its mucous lining.

Occasionally, the injury is limited to the zygomatic arch, there being two lines of fracture in the arch, with a depressed fragment between. This causes a visible and palpable hollow in front of the ear, crepitus may be present, and there is usually interference with the movements of the mandible from pressure on the underlying temporal muscle and coronoid process. In an old case of this kind, seen by us, mal-union resulted in fixation of the lower jaw due to callous and fibrous adhesions connecting the depressed zygomatic arch with the coronoid process.

X-ray Diagnosis.—The usual positions for obtaining roentgenographic films to show fracture lines and depressions of the bone in this region frequently give unsatisfactory results. The technic suggested by Stone in the



FIG. 12.



FIG. 13.

FIG. 12.—Depressed fracture of right malar bone.

FIG. 13.—Röntgenogram showing depressed fracture of right malar bone.

paper quoted is, in his opinion, superior to any previously used. A superoinferior view of the skull is made by having the patient rest the chin on the edge of the table, the tube being beneath the table and the plate on top of the head. Fig. 13 gives a good view of a depressed fracture of the right malar bone.

Treatment.—Depressed fracture of the body of the malar bone. This consists in elevating the depressed bone to its normal position as soon after injury as possible. When this is attempted during the first few days replacement is usually easy, but if the impaction is allowed to remain undisturbed for two weeks or longer it may be extremely difficult to move the displaced fragment and to retain it in normal position.

The means suggested for elevating the depressed malar bone have been many, including digital manipulation from within the mouth, the use of hooked forceps passed through the skin (Gill³), hooks and elevators applied through external incisions, and elevation by means of a heavy sound passed into the maxillary sinus through the canine fossa (Lothrop) or through an intranasal window (Shea⁶). None of these methods has seemed to be entirely satisfactory in our hands, either because of inadequacy or on account of unnecessary scarring or danger of infection. In our experience one of the most satisfac-

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tory methods of dealing with recent cases is that described by Roberts.⁸ It is as follows: A very small horizontal incision is made three-quarter inches vertically below the outer canthus of the eye through the skin, and is carried down to the bone. A special corkscrew-like instrument is passed through the middle of the depressed bone and by this means a firm hold is obtained whereby the fragment can be manipulated into place. It will usually remain in position without tendency to recurrence of the depression. The screw is withdrawn and the skin incision closed with one fine suture. The remaining scar is negligible. We have employed this method in modified form in several cases, first making a hole with a drill and inserting an ordinary screw hook for manipulation of the depressed fragment. Occasionally there is some



FIG. 14.—Screw-porte. FIG. 15.—Application of screw-porte in elevation of depressed malar bone.

trouble in finding the hole in the bone after withdrawing the drill. The screw hook has the advantage in case of tendency to recurrence of the deformity that it can be left *in situ* to afford a means of traction by connecting it with an elastic band to a metal bar on a plaster head cap. In two cases we have elevated the depressed malar bone with the dental instrument known as a "screw-porte" (Fig. 14). The screw end of this is firmly fixed in the bone through the small skin incision and the bone raised by manipulation with the handle of the instrument (Fig. 15).

Probably the most efficient means of dealing with these depressed fractures, especially in older cases, is that described by Gillies, Kilner and Stone.⁴ "A curved incision, one and a half inches long, is made over the temporal muscle and well within the hair line; the edges are retracted; a small incision is made in the temporal fascia; and a long, thin elevator is passed downwards

on the surface of the temporal muscle until it lies deep to the displaced bone. When the lever is inserted in the correct fascial plane it slips under the depressed bone in a most convincing manner, while the operator's hand rests on the firm support given by the skull. The latter should be protected from local pressure injury by a large gauze pad. By careful levering movements the whole bony mass is elevated into correct position; a finger on the various points of fracture is used as a guide to determine when this result has been achieved. In old neglected cases it is often necessary to cut down on individual points of fracture before the bone can be satisfactorily freed; the lines of incision required for this are frequently decided by scars already present. In most cases, however, it is possible to refracture at these points by means of a chisel or osteotome driven into the lines of fracture from the temporal incision. . . . The temporal incision is closed in the usual way, and no drainage is necessary."

We have employed Gillies' method in three cases with very satisfactory results.

For depressed fracture limited to the zygomatic arch, the method of Matas⁷ is most efficacious. A heavy curved needle is passed through the skin from above downward beneath the depressed fragment to emerge below the arch. This needle is threaded with heavy silk, which, in turn, serves as a carrier for a piece of silver wire. The two ends of the wire are twisted together and afford a means of traction on the bone fragment whereby it is elevated into position. In case of tendency to recurrence, the wire is twisted over an ordinary glass microscopic slide whose ends rest on the firm portions of the bone. In old cases, where adhesions and callus formation have bound down the depressed fragment to the underlying coronoid process, limiting the movements of the mandible, an open operation becomes necessary to free the latter.

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GASTRO-INTESTINAL OBSTRUCTION—FUNCTIONAL AND ORGANIC

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THIS paper will deal with the problem of gastro-intestinal obstructions, of both the functional and organic types, from the viewpoint of the pathologic physiology involved, with special emphasis on the post-operative treatment.

Physiology of Intestinal Movement.—In our studies of the gastro-intestinal tract in the past, we have concerned ourselves chiefly with its secretory activities, not giving its motor function the consideration it deserves. Of the two functions, the latter is the more important in that secretory dysfunctions usually result in subacute and chronic morbidity, whereas any serious restriction of motor function manifests itself in acute pathology with rapidly fatal consequences.

Intestinal movements are mainly of two types, the rhythmical contractions and the true peristaltic waves. The rhythmic contractions are myogenic in their origin, the smooth muscle of the bowel possessing the inherent power of contractility, similar to that of cardiac muscle.

Peristaltic waves are neurogenic in origin, although they occur after severance of all connection with the brain and spinal cord. Peristalsis is absolutely abolished by painting the intestine with nicotine or cocaine. They must therefore be ascribed to the local nervous system contained in the myenteric (Auerbach's) plexus, which is regarded as a lowly organized nervous system with practically one reaction, namely, that of producing a progressive contraction wave.

Peristalsis is, however, subject to some regulation by the central nervous system by way of the sympathetics and parasympathetics. Stimulation of the vagus produces increased contractions, while stimulation of the splanchnic nerves causes complete relaxation of the muscularis of the small gut.

Mechanism of Functional Obstruction.—The sequence of events in functional obstruction or paralytic ileus seem to us to occur about as follows: (1) Loss of tonicity of the gut through splanchnic stimulation, brought about reflexly by peritoneal inflammations or irritations, such as occur most frequently in peritonitis or operative interventions involving the peritoneum or intestinal musculature. (2) This primary inhibition of peristalsis results in gaseous distention—not, as formerly thought, by bacterial fermentation of the stagnated intestinal content (this accounts for but little of the accumulation), but because of decreased absorption of gases from the bowel by the blood-stream. The lost tonicity of the bowel wall decreases the rate of the local blood circulation, thus slowing gaseous absorption. (3) Dehydration is another factor which causes a more sluggish circulation in the intestinal

mucosa, further aggravating the tympanites by disturbing the normal gaseous exchange. (4) This distention acts to lessen absorption of gases by impairing the mesenteric circulation on the venous side and, in addition, diffusion of gases from the blood into the bowel lumen is much increased.

As distention increases the pendulum movements of the gut stop first, then the rhythmic contractions and the true peristaltic waves last. When the pressure within the intestine equals the venous pressure, necrosis results.

(5) The partial ileus resultant from these factors in some manner, probably through circulatory disturbance in the intestinal wall, brings about the elaboration of a specific toxin which reduces the contractility of smooth muscle and has a paralyzing action on Auerbach's plexus, similar to that of nicotine when painted on the peritoneum of the experimental animal.

This last action completes the picture of complete motor inhibition or paralytic ileus, the result being a functional obstruction as dire in its consequences as that produced by organic obstruction.

That obstruction can occur without any narrowing of the lumen at all can be shown by an experiment of Alvarez,¹ which we have repeated. The abdomen of a rabbit is opened under normal saline and the intestine clamped with a hemostat and released so as to bruise a ring of gut. The abdomen is closed and opened several hours later, when we observe the interesting fact that no food has passed the site of injury. Although ample peristaltic waves pass downward, they are seen to break up on approaching the ring of injured tissue. The proximal loops are found distended with gas.

Nature of the Toxæmia.—As regards toxæmia, we believe that gastrointestinal obstructions of both the functional and organic types should be divided into two main groups: (1) Simple obstructions or occlusions; and (2) obstructions complicated by circulatory insufficiency of the bowel wall.

In the first group there is no true toxæmia. These patients suffer from dehydration, upset acid-base balance and disturbance of ionic equilibrium as a result of lost electrolytes. These three conditions are all due to loss of digestive secretions through vomiting.

Whether an acidosis or alkalosis develops depends on the relative amounts lost of the acid gastric juice as compared to the alkaline bile, pancreatic and intestinal secretions.

We must remember, too, that many of these patients only "vomit" as far as their stomachs. Lavage may show marked retention from gastric dilatation and these secretions are lost to the body as no absorption takes place from the stomach. Obviously in this first group the symptoms will be more severe the higher the obstruction.

In the second group of cases one may have the foregoing problems to deal with, and, in addition, a true toxæmia.

The many theories regarding the nature of this toxæmia will not be gone into here. Suffice it to say, however, that our personal opinion is that a specific toxic substance is formed as a result of local circulatory deficiency.

We believe this toxin is elaborated in the mucosa of the greater part of

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the small intestine, but chiefly of the duodenum, and is in part excreted into the lumen of the intestine, but the larger portion absorbed by way of the lymphatic stream.

Such a toxic substance has been isolated by Ellis,² which, when injected into dogs, produces the symptoms and signs of obstruction and sometimes death.

Any Group I case of simple obstruction may pass over into the more severe form of Group II if improperly treated. The loss of tonicity, dehydration and increased intra-intestinal pressure, acting together, depress the circulation, and so interfere with cellular nutrition that degenerative changes take place, and, finally, actual necrosis.

Clinically, we find combinations of these two groups of obstructions and the differential diagnosis is extremely difficult, if not impossible.

Chemical and Clinical Observations.—The deviations from the normal chemical findings, all are familiar with, namely, the increased carbon-dioxide combining power of the blood plasma, the blood-nitrogen retention and the decrease in the blood chlorides. It matters not what causes the obstruction or whether it is functional or organic in nature, the chemical changes from the normal are the same.

These chemical changes are preceded by early clinical symptoms and signs of obstruction.

No single laboratory test is to be relied upon in confirming a diagnosis.

Not only is the blood chemistry similar in the two types of obstruction but the clinical pictures are also very much the same. Both functional and organic types present tympanites, gastric retention, nausea, vomiting, abdominal distress, oliguria, anhydraemia and later disorientation with that peculiar mental alertness, subsultus and the typical Hippocratic facies. The organic type of obstruction is usually more tumultuous in onset and more rapid in its development than the functional, which is more insidious; otherwise, there is little difference.

Post-operative Treatment.—One should not rest upon one's surgical laurels after relieving a mechanical obstruction of the bowel, especially in the more proximal portions of the gut. The release of possible noxious substances retained above the obstruction in that section of the gastro-intestinal tract chiefly concerned with secretion into the lower jejunum and ileum, where the major function is one of absorption, may prove rapidly fatal.

One should also keep in mind that paralytic obstruction may result from strangulation and persist even after the strangulation has been relieved.

One should not wait until motor inhibition is well developed and then rely upon the rectal tube, gas-dispelling enemas and pituitrin.

We should realize by this time that our peritonitis patients seldom die from their peritonitis, but rather from obstruction. The plastic exudate formed by the peritoneum is an effective barrier to the passage of bacteria and their toxins from the peritoneal sac (as David³ has shown). If we

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treated these peritonitic patients primarily as cases of obstruction, we would effect a great reduction in our mortality rates.

In the treatment of peritonitis it is not sufficient to return the patient to bed from the operating table, there to be placed in the Fowler position with an ice-bag on the abdomen and an order for 2 per cent. soda and 5 per cent. glucose by proctoclysis. Such therapy has long proved itself inadequate.

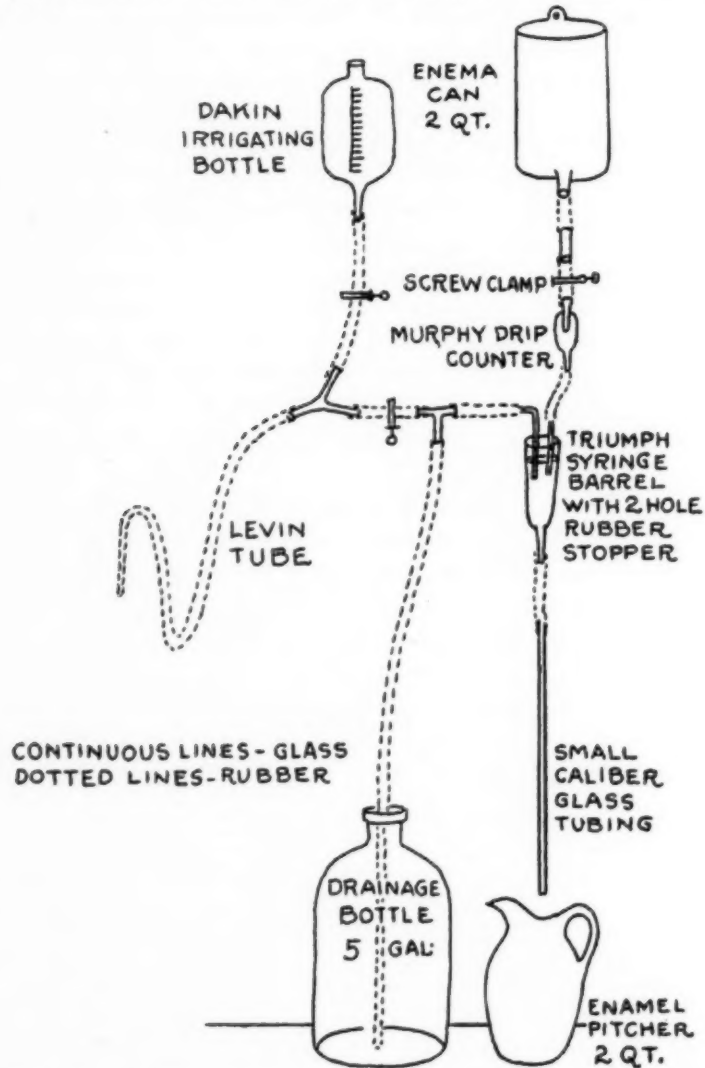


FIG. 1.—Connell apparatus as set up in Hollywood Hospital by Gurn Stout, M.D.

While there should be no such thing as a routine treatment in medicine, it is, however, advisable to have a campaign of action in mind, otherwise our efforts are apt to be so dispersed as to be of little value.

For these obstructive cases we would consider the following treatment appropriate.

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1. Removal of toxic bowel contents by continuous gastric and duodenal drainage and lavage. (a) This is done by passing a 14-gauge Levin tube transnasally to the duodenum. This tube, held in place by adhesive to the cheek, is to be retained indefinitely. (b) This tube is connected to some apparatus for providing a continuous, mild, negative pressure. We have found the simplest and most satisfactory apparatus for general use to be the Connell suction, with an intermediate arrangement providing for instillation and drainage of liquids to and from the duodenum (Fig. 1).

2. Exhibition of sodium chloride and stabilization of ionic equilibrium and acid-base balance. From 45 to 100 grams of sodium chloride are given each twenty-four hours, as follows: (a) From 2 to 4 ounces of 4 per cent. saline, containing 1 gram of di-basic sodium phosphate, 3 grams of potassium dihydrogen phosphate and 3 grams of di-basic potassium phosphate per liter, are passed through the Levin tube to the duodenum every two hours.

The phosphates are added to replenish the essential mineral potassium and to aid preservation of neutrality by means of the following chemical equation:



(b) One to 2 liters of saline are given by hypodermoclysis every twenty-four hours, (c) One liter of 1 per cent. saline is given intravenously every six to eight hours. (d) 10 per cent. glucose is sometimes added to the intravenous solution in case of oliguria, otherwise it is omitted.

3. Prevention of anhydræmia. The administration of the chlorides and phosphates as indicated provides a fluid intake of from 4 to better than 6 liters per day. More may be necessary. Water is given freely by mouth if there is no vomiting or gastric retention.

Proctoclysis as a means of giving fluids is not to be relied upon at all. If given, use saline. Glucose is not absorbed from the colon and its use should be discontinued.

A high-fluid intake is absolutely necessary to combat the dehydration present in these cases and is a very important part of the treatment.

4. Rest.—(a) The patient is placed in the semi-Fowler position with knees flexed. (b) Hot abdominal stupes for added comfort. (c) Sleep is provided for with sedatives such as phenobarbital sodium and sodium amytal. As little morphine as possible is used. (It is well to remember that animals can live longer without food than without sleep.)

5. Nourishment.—This is disregarded the first week in serious cases. (a) If thought advisable, 5 per cent. glucose may be added to the intravenous solutions occasionally.

(b) If, in the second week, the patient is unable to take food, nourishment is given through the duodenal tube. We have used the following recipe with satisfaction: Di-basic sodium phosphate grams, 1; mono-basic potassium phosphate grams, 3; di-basic potassium phosphate grams, 3; sodium chloride grams, 20; glucose grams, 50; lactose grams, 100; dextrin, grams, 100; pep-

tone grams, 50; water 1 liter. Calcium caseinate grams, 25, is added to the above if bowels are loose. From two to four ounces is given through the tube every two hours.

(c) After the patient has rounded the turn in the road to better health, a greater amount of nourishment can be given through the tube if it proves necessary and desirable. In this case we add the following to furnish fats and vitamins; 20 per cent. cream 180 cubic centimetres; egg yolk 2; olive oil 15 cubic centimetres; cod-liver oil 15 centimetres; malt extract with iron 1 tablespoon. This formula is given in twelve feedings. Orange juice is given by mouth.

With the above formula it is possible to give the patient a four and one-half ounce, well-balanced meal every two hours providing the essential vitamins and a caloric intake of 2575; sufficient for an average-sized man doing a good day's work.

No catharsis is attempted and no effort is made to stimulate peristalsis directly.

The successful use of this treatment requires a full knowledge of the principles involved and careful attention to details.

Comment.—Many operators have reported a reduction in their mortality rate by use of early jejunostomy. The common practice, however, is to resort to the operation only as a last resort.

The use of such an apparatus as described for continuous gastric and duodenal drainage will accomplish all that a jejunostomy will and more. It can be utilized early; the patient is not subjected to the risk of a secondary operation; there is no fistula to contend with; the apparatus is under perfect control at all times and is born by the patient with but slight discomfort. If the tube should be removed prematurely, patients will often ask for its replacement because of the comfort afforded. The apparatus should be kept in use until all danger from intestinal paresis is past.

This apparatus removes a considerable part of the toxic-bowel content and also provides a ready means of placing hypertonic saline directly into the upper intestine, where theoretically it might accomplish the most good.

One criticism that has been directed against duodenal drainage is that it removes more fluids than are given orally. While this is true early in treatment, there is a gradual reversal as the patient's condition improves. It is the parenteral injections of saline that are relied on to relieve anhydræmia rather than fluids given through the tube.

The lack of food during the first week produces a mild acidosis that takes care of the initial alkalosis. These patients readily develop acidosis of a marked degree and for this reason we feel that the use of hydrochloric acid is inadvisable and unnecessary.

Sodium-chloride solutions injected intravenously will augment peristalsis. This interesting fact was discovered by Hughson and Scarff,⁴ while experimenting with the isolated segment of intestine in cats.

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SUMMARY AND CONCLUSIONS

Functional obstruction of the gastro-intestinal tract, the result of motor inhibition, is a common occurrence. It should be watched for and given the same serious consideration as organic obstruction.

The exhibition of chlorides, upper intestinal drainage and forcing of fluids that have proven effective in reducing the mortality rate in the organic obstructions are just as effective in the treatment of the functional type.

One should be on the lookout for obstructive signs following any laparotomy. These early signs are oliguria, gastric retention, tympanites, restlessness, nausea, vomiting and abdominal distress. These signs are present before the characteristic blood changes and call for treatment as above outlined.

Many patients would overcome their peritonitis if the toxæmia resulting from the functional obstruction, that is always present, were cared for.

The discovery of any degree of peritonitis whatever in the performance of an abdominal section should be the signal to anticipate ileus by starting treatment at once.

Patients suffering from generalized peritonitis who enter the hospital moribund should not be operated upon at once, as they die within a few hours. A period of pre-operative treatment as outlined will often convert the case from a sure death risk, to one offering a fair chance of success.

In all types of obstruction the early post-operative use of the therapeutic measures suggested will accomplish a reduction of mortality rates.

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APPLICATION AND INTERPRETATION OF BLOOD SUGAR TIME CURVES IN THE DIAGNOSIS AND TREATMENT OF SURGICAL INFECTIONS OF THE GALL-BLADDER AND BILIARY PASSAGES

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THE use of blood sugar time curves as an aid in the diagnosis, and as a guide to the extent of operative treatment, of infection of the gall-bladder and the biliary passages has been a routine in this hospital for a number of years and some of the results have been referred to previously.^{1, 2, 3} As an adjunct to the diagnosis of cholecystitis, these curves were regarded as the most reliable of all laboratory tests then made use of. Other tests included (a) single estimation of blood sugar in the fasting state, (b) the van den Bergh reaction, (c) quantitative determination of urine urobilinogen, (d) fat partition of faeces and (e) X-ray visualization of the gall-bladder. In a more recent report,⁴ Ritchie and Rabinowitch have shown, with regard to the combined use of X-rays and blood sugar time curves, that diagnosis was practically certain for or against when agreement was found between the results of these two tests. The number of cases then reported was small, but the data suggested, providing the tests were properly applied and interpreted, that a very satisfactory state had been reached with respect to diagnosis. The purpose of the present report is to demonstrate the value of blood sugar time curves as an indication of the extent of surgical treatment demanded and a guide to the post-operative progress of the patient.

As with all laboratory procedures, proper application and interpretation of tests made use of in the study of biliary disease depend upon proper appreciation of the physiological principles upon which each test is based. For example, X-rays may indicate disease of the gall-bladder directly; whereas the blood sugar time curve affords indirect evidence only, the type of curve obtained depending upon the presence or absence of an associated pancreatitis.

Though referred to in previous publications of this hospital, a brief outline may here be given of the factors which must be considered when blood sugar time curves are used in the study of disease of the biliary passages. In view of the physiological principles upon which the test is based, it is obvious that there are conditions other than disease of the biliary passages which may lead to abnormal curves, as noted in the following observations:

Principles of the Test.—The response of an individual to glucose ingestion depends essentially upon (a) the rate at which the ingested glucose is absorbed from the alimentary canal and (b) the rate at which the absorbed glucose is utilized. (By utilization is meant the combined mechanisms of oxidation and storage.) If either oxidation or storage be faulty, the rate

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of absorption may be greater than the rate of utilization. The result is hyperglycemia. A variety of conditions are now recognized as being associated with defective utilization and these must be excluded before hyperglycemia is attributed to pancreatitis. On the other hand, if the mechanism of absorption of glucose be impaired, the rate at which the ingested glucose reaches the tissues may be so slow that hyperglycemia may not be produced in spite of some minor defect of utilization. Under these conditions it is possible to obtain perfectly normal curves in individuals who are definitely known to be diabetic. Excluding organic disease of the gastro-intestinal tract, a common cause of defective absorption of glucose is faulty preparation of the glucose drink. In view of the importance of this part of the test, a few observations may be made with regard to it.

Details of Test.—A blood sugar time curve obtained following glucose ingestion is one of the most sensitive tests available clinically for the detection of disturbed carbohydrate metabolism. As with many sensitive tests, however, the reliability of the data varies directly with the degree of exactness with which the test is performed in all its details and one of the latter, as just stated, is the preparation of the drink. The common practice is to give 100 grams of glucose dissolved in a glassful of water flavored with lemon juice. The solution is, therefore, hypertonic. In the mixture used by us, the total volume of liquid is 250 cubic centimetres. This represents a 40 per cent. solution of glucose. Hypertonicity may, *per se*, be responsible for defective absorption of glucose from the gastro-intestinal tract. In our experience, however, the greatest source of error lies in the ease with which it is possible to produce a most unpalatable and nauseating drink, unless careful attention is paid to the flavoring and chilling. When properly flavored and chilled, a glucose drink can be made very attractive, especially when given after the twelve to fifteen hour fasting period necessary before the test. In this hospital, no drinks are prepared in the wards; all are prepared in the metabolism laboratories, are kept there on ice until required and *tasted before they are given to patients.**

The staff of the metabolism department is also responsible for the administration of the drink and the accurately timed collection of blood specimens for analysis. The metabolism nurse who takes the blood administers the drink and stands by the bed-side of the patient until it has been taken, and notes the time. Our thirty, sixty, etc., minute specimens therefore represent exactly the blood sugars at those periods. This might be regarded as a minor detail. In our opinion, however, it is otherwise. As it is obviously important to compare things with things which are comparable, it may here be observed that the standard curves used for comparison are based upon the collection of accurately timed specimens of blood, and blood sugars vary with elapsed time.

*Some idea of how attractive this drink can be made may be gained from the fact that patients suffering from acute febrile disorders (pneumonia, etc.) may be induced to take five or six hundred grams of glucose a day, representing 2000 or 2500 calories.

Incidentally, at each visit to the patient, the metabolism nurse makes careful note of any possible mishap during the test (loss of urine, accidental ingestion of other food or fluids, etc.).

Of course, all tests are commenced in the morning in the fasting state, at least twelve to fifteen hours after the evening meal of the preceding day. Judging from the literature, the practice of testing the effects of glucose administration during the day after an ordinary meal is not uncommon. An important fact to consider with such a practice is that ingestion of sugar in any form stimulates the mechanism of its utilization and the effects upon the blood content of administration of a second dose may not be as marked. Blood sugar time curves obtained with repeated doses of glucose strikingly demonstrate this phenomenon.^{5, 6} A brief description may here be given of what, in our opinion, constitutes a normal curve, as there is some disagreement amongst workers in this field.

Attributes of blood sugar time curves.—There is general agreement as to the normal content of the blood sugar in the fasting state, that is, before any glucose is given; it ranges between 0.08 and 0.12 per cent. It is also agreed that the blood sugar should return to normal two hours after the glucose is given. As a matter of fact, the above information, probably because of the general agreement, is all that is required by some life assurance companies, when glycosuria is discovered in an applicant. The two other attributes of the curve, with regard to which there is disagreement, are (a) the "peak", that is, the maximum height which the blood sugar reaches sometime during the test, and (b) the "lag", that is, at times, instead of the blood sugar rising rapidly and reaching its maximum at the thirty minute period, it may rise gradually and reach the peak at the sixty minute period or later. Based upon experience of over 4000 curves, all obtained with the same type sugar, the same amount sugar and the same technic of blood sugar estimation; based also upon correlation of clinical with laboratory data, it is our opinion that both the "peak" and the "lag" are important attributes to consider. A curve, in our opinion, is, therefore, regarded as normal only when

(a) The blood sugar in the fasting state (before glucose) is normal (0.08 to 0.120 per cent.).

(b) After glucose, the maximum blood sugar ("peak") is not greater than 0.180 per cent.

(c) The "peak" occurs at the thirty minute period.

(d) The blood sugar is again normal, or below, at the 120 minute period, that is, two hours after the glucose is given.

Methods of estimating blood sugar.—With regard to interpretation, an important consideration is the use of different methods of blood sugar estimations. The values obtained with the different methods differ, and the newer methods give lower blood sugar values than the older procedures. For our routine work we still adhere to a slightly modified form of the Myers-Benedict procedure. This test has received much criticism and the general tendency is to discredit it. The following observations may, therefore, be made.

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The state of our knowledge with regard to blood sugar methods may be learned from a glance at the literature. The number of methods, alone, demonstrates the unstable nature of the different procedures. One observes repeatedly that a method is reported and the author's conclusion from experience with it is that ideal conditions have been approximated very closely. Shortly, however, with further experience, the same author discovers a number of variables and introduces a new method, which, in turn, is shortly again discarded by its author.

Though there are a variety of methods of estimating blood sugar, in principle they have much in common. For example, the first procedure consists of laking the blood and precipitation of proteins, in order to obtain a clear solution after filtration. A known amount of the clear filtrate is treated with some reagent which is reduced by yielding up the oxygen necessary for oxidation of the aldehyde group of the sugar and the measurement of the degree of reduction of the reagent is made use of as an index of the amount of sugar present. In general, the procedures fall into two groups, namely, titrimetric and colorimetric. Amongst the former are found such methods as the Bang, Maclean, Hagedorn-Jensen and Shaffer-Hartmann. The method we use belongs to the colorimetric group and depends upon the development of a red color due to the reduction of the picrate to a picramate. The variety of Folin procedures are also colorimetric and depend upon the reduction of an alkaline copper solution with the formation of cuprous oxide and determination of the latter by its oxidation with another reagent, which in turn is reduced with formation of a blue color the intensity of which is proportional to the amount of cuprous oxide and therefore, sugar. With regard to results in general, colorimetric methods yield higher values than titrimetric. No one test is specific for glucose, except the rather elaborate fermentation methods and these are not practical for routine work. In selection of a method from those mentioned, there are a number of considerations other than specificity. These were discussed in a previous communication. Some observations may here briefly be referred to.

With all tests, the most important matter is appreciation of the underlying chemistry, and recognition of the many technical variables which influence results. The selection of a method merely because of its author, and its use mechanically with no knowledge of its chemistry, regardless of its degree of approach to specificity for glucose, is the chief cause of erroneous data and skepticism on the part of the clinician about the value of laboratory tests in medicine. With regard to the picric acid procedure, the following may be observed. We have now had experience with over 50,000 blood sugar determinations and, as a result of this experience, it may be re-stated that if careful attention be given to details (purification of picric acid, uniform concentration of picric acid in the blood filtrates, uniform proportions of filtrate and alkali in the boiling mixture, avoidance of prolonged exposure of picric acid solutions to light, etc.), the method combines simplicity of technic with uniformity of data—a more important matter in clinical practice than specificity. The observation⁷ may also here be re-

peated that we are quite in agreement with Benedict in his assertion that rarely has the clinician been misled by the data obtained with this method of blood sugar estimation. We have frequently noted the fact, mentioned by Benedict⁸ that blood sugar, by this method, parallels the clinical progress of the diabetic more closely than the results of Folin-Wu method, with which a decline in blood sugar concentrations is found to be more rapid. It may here be observed that all new methods, as they appear in the literature, are given a fair trial, from point of view of accuracy and practicability.

Having performed the test with careful attention to all details and having excluded the many conditions other than pancreatitis which may lead to abnormal curves, there remains one condition which may be dealt with separately, but is commonly associated with cholelithiasis and cholecystitis and not always readily recognized clinically, namely, hepatitis. Hepatitis may, *per se*, be responsible for defective storage of glucose, and with such defective storage, the blood sugar time curve may be identical with that seen in pancreatitis. The effects of hepatitis may be, however, fairly readily measured by the combined use of the van den Bergh reaction for bilirubin in blood and the test for urobilinogen in urine. By correlating our data, we have only rarely been able to attribute an abnormal blood sugar time curve to hepatitis, when the blood showed less than 0.5 milligrams of bilirubin per 100 cubic centimetres (van den Bergh equals 1 unit); or when urobilinogen was present in urine in less than 1 in 50 dilution, according to the Wallace and Diamond technic.⁹

The use of blood sugar time curves as an index of treatment and progress of disease of the gall-bladder and its passages will now be outlined.

As stated above, the test affords indirect evidence of disease of the gall-bladder; it depends upon the presence or absence of pancreatitis; and our use of the test as an index of treatment and progress depends upon the assumption that the course of an individual suffering from pancreatitis is somewhat similar to that noted in partially depancreatized animals. For example, Allen¹⁰ has clearly shown that it is possible to remove, within certain limits, pancreatic tissue from the dog without the production of diabetes; the animal may develop glycosuria, but, if properly dieted, the glycosuria disappears and the animal does not subsequently develop diabetes. It is suggested that the latter condition is somewhat similar to the mild and temporary hyperglycæmia and glycosuria occasionally seen in man with disease of the biliary passages complicated by pancreatitis. With adequate surgical treatment of the biliary disturbance and dieting, the hyperglycæmia and glycosuria disappear and the individual does not subsequently develop diabetes. With inadequate or delayed treatment, however, the pancreatitis becomes chronic and as the disease progresses, with loss of more and more pancreatic tissue, the individual subsequently develops diabetes. The following curves taken from many hundreds are cited as representative of possible courses of events in patients treated for cholecystitis and cholelithiasis (*a*) by operation with and without special diets, and (*b*) without operation with and without special diets.

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That diet alone may lead to improvement of pancreatic function is well known. The most rapid recoveries noted without operation occurred in seventeen and twenty-four days respectively. Thus:

			Blood sugar (per cent.)				
	Date		Fast- ing	30 min.	60 min.	120 min.	150 min.
Hosp. No. 2806/30	May	28/30	0.128	0.212	0.256	0.312	0.285
	June	14/30	0.119	0.217	0.238	0.188	0.109
Hosp. No. 5815/25	November	14/25	0.172	0.340	0.344	0.280	0.220
	December	8/25	0.145	0.230	0.333	0.280	0.160

It will be noted that, in neither case, is the curve following treatment normal. In the first case (2806/30) though there is no longer suggestive hyperglycæmia in the fasting state, and the blood sugar is normal at the end of the test, the "peak" is still high, there is a "lag" and there is still hyperglycæmia at the 120 minute period. In the second case (5815/25), there is hyperglycæmia at all periods, including the fasting state. The curve is, however, distinctly lower than before the patient was subjected to dietetic management.

Very rarely have we observed a perfectly normal curve in an individual treated by diet alone. The usual picture is as follows:

			Blood sugar (per cent.)				
	Date		Fast- ing	30 min.	60 min.	120 min.	150 min.
Hosp. No. 1829/30	May	31/29	0.153	0.230	0.350	0.250	0.185
	April	5/30	0.120	0.185	0.188	0.175	0.120

It will be noted that though the blood sugar is normal in the fasting state and at the end of the test, there is still hyperglycæmia at the 120 minute period, in spite of rigid adherence to diet for about ten months.

The time for recovery of pancreatic function varies, as one would expect, with the individual, and depends upon a variety of factors such as (a) the duration of the disease before operation, (b) the severity of the disease, (c) the number of acute or subacute attacks of pain, etc., (d) the diet before and after operation, and, it is our impression (e) the type of operation, namely, cholecystotomy or cholecystectomy and, in the case of cholecystectomy, whether the common bile duct was, or was not, drained. The following two cases demonstrate the rate of recovery dependent upon the degree of impairment of pancreatic function prior to operation. In both cases, the recheck curves were obtained six months after operation.

All conditions were apparently the same in both cases, except that there was a longer history of illness prior to operation in the second case (2700/29). Note the more marked impairment of pancreatic function before operation in this case. It will be noted that the only abnormalities in the curve of the first patient prior to opera-

			Blood sugar (per cent.)				
	Date		Fast- ing	30 min.	60 min.	120 min.	150 min.
Hosp. No. 2223/29	April	12/29	0.105	0.153	0.175	0.161	0.112
	October	21/29	0.091	0.100	0.104	0.080	0.044
Hosp. No. 2700/29	May	14/29	0.145	0.196	0.212	0.200	0.128
	November	28/29	0.125	0.200	0.175	0.122	0.113

tion were (a) hyperglycæmia at the two-hour period and (b) a "lag." In the second case, the entire curve was abnormal except for the normal blood sugar at the end of the test.

Note the hypoglycæmia at the end of the post-operative test in the first case. This

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suggests a remarkably efficient mechanism of utilization of carbohydrates. In the other case (2700/29), two abnormalities are still present, namely, (a) a blood sugar on the borderline of hyperglycemia in the fasting state, and (b) a maximum blood sugar of 0.200 per cent.

The most ideal results were obtained when operation was not delayed and in addition to operation, the patients were assumed to be diabetic for the time being and dieted accordingly. The following is a representative sample:

	Date	Blood sugar (per cent.)				
		Fast- ing	30 min.	60 min.	120 min.	150 min.
Hosp. No. 2101/29	April 16/29	0.128	0.212	0.312	0.295	0.285
	September 2/30	0.111	0.151	0.166	0.090	0.112

It will be noted that, in spite of slight hyperglycemia in the fasting state, a "lag" and marked hyperglycemia throughout the test, the curve is normal seventeen months later, except for the slight "lag."

As stated before, very little attention had been paid by some other observers to the "lag." By following the practice of some insurance companies who request only the blood sugar in the fasting state and again two hours after glucose ingestion, not only is the "lag" not detected, but the "peak" of the curve may also be missed, since, in mild disturbances of carbohydrate metabolism, the "peak," as in the normal curve, may be reached at the thirty minute period. The following case is an example.

	Date	Blood sugar (per cent.)				
		Fast- ing	30 min.	60 min.	120 min.	150 min.
Hosp. No. 2159/30	April 22/30	0.120	0.200	0.137	0.112	0.117
	December 5/30	0.107	0.178	0.185	0.161	0.123

In this case there was a definite diagnosis of pancreatitis. The "peak" was, however, the only indication of abnormal carbohydrate metabolism. The blood sugar of the fasting period and two hours after glucose ingestion would have alone yielded little information. Further suggestive evidence that the carbohydrate metabolism was not normal in this case are the characteristics of the curve obtained after operation. It will be noted that there was not only a "lag," but definite hyperglycemia at the two-hour period and a blood sugar on the borderline of hyperglycemia at the end of the test*.

With regard to fasting blood sugars on the borderline of normality, it here may be observed that, when correlated with time curves, the majority are abnormal.⁷

The combined effects of delayed operation and irregular diet, in spite of persistence of signs and symptoms of fairly active disease are shown in the following case. The diagnosis of cholelithiasis was made in May, 1929. The patient refused operation and followed diet irregularly. In August, the same year, because she was told the results of the test were identical with those of diabetes, she commenced to follow diet more rigidly. There was temporary improvement of carbohydrate tolerance as shown by the curve obtained in April, 1930. In August of the same year, however, the curve suggested downward progress. In fact, the carbohydrate metabolism was more disturbed than when the patient was first seen. She has since been operated upon.

*Failure to detect the peak of the curve has, frequently, judging from the literature, accounted for a diagnosis of renal glycosuria. The diagnosis in such cases was largely based upon the finding of glycosuria accompanied by blood sugars below the generally accepted renal threshold values. A discussion of this phase of the subject will be found in a recent publication from this hospital¹¹ on renal glycosuria.

BLOOD SUGAR IN BILIARY INFECTIONS

			Blood sugar (per cent.)				
Hosp. No.	Date		Fast-	30	60	120	150
			ing	min.	min.	min.	min.
Hosp. No. 2534/30	May	15/29	0.101	0.200	0.181	0.166	?
	August	16/29	0.087	0.277	0.232	0.212	0.244
	April	28/30	0.122	0.178	0.217	0.178	0.128
	August	27/30	0.123	0.212	0.238	0.178	0.140

We learned early in our experience that blood sugar time curves are of no value, and in fact may be misleading, when obtained too soon after operation. Apparently with the unavoidable manipulation at operation there is a tendency towards exaggeration of pancreatic disturbance. The following two cases demonstrate this phenomenon:

			Blood sugar (per cent.)				
Hosp. No.	Date		Fast-	30	60	120	150
			ing	min.	min.	min.	min.
Hosp. No. 1189/29	January	9/29	0.116	0.161	0.200	0.180	0.090
	Operation: March 11, 1929						
	April	24/29	0.117	0.217	0.232	0.181	0.156
	February	18/30	0.100	0.137	0.135	0.113	0.107
Hosp. No. 5386/29	September	14/29	0.104	0.192	0.153	0.120	0.128
	Operation: September 23, 1929						
	October	11/29	0.122	0.200	0.217	0.162	0.147
	January	27/30	0.102	0.175	0.169	0.140	0.125

In both cases it will be noted that, in addition to the abnormalities of the curves prior to operation, there was definite hyperglycemia at the end of each test performed shortly after operation. In the first case, the curve was found normal thirteen months after operation. In the second case, recovery from the temporary aggravation is noted three months after operation.

A factor to consider in the first case is that some time (two months) elapsed between the time of the first curve and the operation. It is, therefore, possible that the curve obtained shortly after operation was caused by progressive pancreatitis due to delayed operation, rather than by the operation, *per se*. This would not, however, explain the post-operative curve of the second case (5396/29), the operation having been performed nine days after the first test.

The following two cases demonstrate that, in spite of all care, surgical and dietetic, the disease may progress to diabetes. In the first case (4060/29), the operation was performed shortly after the diagnosis was made and there were no residual symptoms. The results were as follows:

			Blood sugar (per cent.)				
Hosp. No.	Date		Fast-	30	60	120	150
			ing	min.	min.	min.	min.
Hosp. No. 4060/29	July	18/29	0.104	0.158	0.250	0.263	0.217
	May	8/30	0.135	0.178	0.227	0.208	0.139

It will be noted that there is hyperglycemia in the fasting state, ten months after operation.

The next case is that of a physician. The diagnosis was made in September, 1928. The effects of diet were tried and in February, 1929, the clinical condition was worse. In February, 1930, he was operated upon and there appeared to be some improvement clinically and also judging from the curve of April, 1930. The most recent curve, however (March, 1931) shows progressive disease. The data fit the clinical picture.

			Blood sugar (per cent.)				
Hosp. No.	Date		Fast-	30	60	120	150
			ing	min.	min.	min.	min.
Hosp. No. 1149/29	September	27/28	0.096	0.181	0.200	0.107	0.103
	February	5/29	0.131	0.204	0.244	0.169	0.105

RABINOWITCH AND BAZIN

Operation: February 28, 1930

April	25/30	0.122	0.222	0.212	0.200	0.181
March	10/31	0.113	0.161	0.166	0.204	0.232

Considering the group as a whole, the general impression gained by us is that an abnormal blood sugar time curve occurring in a patient with infection of the gall-bladder is an indication of an associated pancreatitis; that adequate surgical treatment and prolonged post-operative controlled diet leads to marked improvement in, or return to normal of, the blood sugar time curve; that inadequate surgical treatment, even with similar controlled diet, does not produce the same satisfactory results. One of the writers (A. T. B.) has made it his practice to assume, when the history, physical examination and X-rays indicate disease, and the blood sugar time curve is not disturbed, that the infection is local, *i.e.*, confined to the gall-bladder; there is no pancreatic involvement. In such cases, in the absence of other indications, the gall-bladder is removed but the common bile duct is not drained. If, however, the blood sugar time curve is abnormal, pancreatitis is assumed and the duct is drained.* Statistical proof of the correctness of this practice is, however, still lacking, in view of the relatively small amount of material compared with the many other variables, which have to be excluded. The latter include diet before operation, diet after operation, duration of illness, severity of illness, number and severity of acute and subacute attacks of pain, etc. However, on the basis of presently available knowledge, this practice seems justified.

The primary purpose of this communication is to indicate a measure for the prevention of diabetes mellitus. Infections of the gall-bladder and the biliary passages account for a large percentage of adult diabetics. It is our opinion that the routine practice described above and which we are following has not been without success.

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*An important observation which may here be referred to is the fact that intravenous injection of phenoltetraiodophthalein for X-ray visualization of the gall-bladder may, at times, cause temporary disturbance of liver function (hepatitis), sufficient to interfere with normal storage of glucose as glycogen. Under these conditions, an abnormal blood sugar time curve may be found in the absence of pancreatitis. It is, therefore, important, and it is our routine procedure, to test the sugar tolerance not after, but BEFORE the patient is given the dye for X-ray purposes.

RAPID HIGH-TEMPERATURE DEATHS FOLLOWING BILIARY-TRACT SURGERY

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SUDDEN death with high temperature following biliary-tract operation is startlingly impressive, and, while uncommon, has occurred with sufficient frequency to arrest my attention.

The condition may be summarized as follows: Between six and twelve hours following a simple, uncomplicated operation in which the immediate pre- and post-operative temperatures are normal and general condition is satisfactory, there is a rapid, steady rise in temperature to 105° F. or 107° F. and death takes place within thirty-six to forty-eight hours. The mentality remains clear but there is extreme nervousness, rapid, weak pulse, low blood-pressure, and, later, shallow, rapid respiration.

Such cases have been reported by Cave, Stanton and others.

Various conditions have been looked upon as possible causes: Hæmorrhage, shock, cardiovascular disease, pulmonary disease or accidents, hyperthyroidism, acute gastric dilatation, peritonitis, cholæmia, liver "shock," or liver "insufficiency."

In hæmorrhage and shock the temperature remains nearly normal. Myocarditis or uræmia does not usually manifest the symptoms encountered in this type of death.

Pulmonary disease or accident is not uncommon following gall-bladder operations.

An example (recent, and to broaden the perspective) from Sweden will be found in the report of Petren¹ entitled "On the Causes of Post-Operative Deaths." In 457 gall-bladder operations there were fifty-four deaths, twenty-two of which were pulmonary.

An appreciation of the frequency of atelectasis and the possibility of its prevention has attracted attention to this type of complication but does not account for the syndrome under consideration.

The similarity to hyperthyroidism has been commented upon, as has the inter-relationship between the thyroid, adrenal pancreas and liver, but reported investigation of liver function and its relation to shock and metabolism fails to clear up this type of fatality.

The occurrence of Charcot's intermittent hepatic fever in common-duct stone suggests a cholangitis as a very plausible explanation but cholangitis is often lacking.

In septic peritonitis the temperature is not so high and death does not take place so rapidly. The few autopsies that have been made did not show a peritonitis.

"Bile peritonitis" has been considered by Sellands, Horrall, and Still as a chemical irritation. Horrall noted this condition to be accompanied by vomiting, which was noted in many of Stanton's cases and is a striking characteristic in six reviewed in this report. (This symptom leads to a suspicion of acute gastric dilatation.)

The recent experiments upon "The cause of Death in Liver Autolysis," by Edmund Andrews and Leo Hardina² and those of Allan G. Rewbridge³ entitled "The Etiological Rôle of Gas-forming Bacilli in Experimental Bile Peritonitis" are noteworthy, but do not explain the cases under consideration.

Stanton contrasts the symptomatology of rupture of the liver and rupture of the spleen and thinks that death following the former and those under discussion have similar operative factors, but what they are he does not know.

In a review of recently published reports of liver rupture, the symptomatology has been that of secondary bleeding and not strikingly dissimilar from that of rupture of the spleen.

In personal cases of rupture of the liver this high temperature reaction has been wanting, as it is likewise in Rewbridge's³ report upon gall-bladder rupture and consequent peritonitis in dogs. His conclusion (which does not necessarily apply to humans) is that *Bacillus welchii* invades the peritoneal cavity presumably as the result of permeability changes produced by the local action of the bile salts.

Such a permeability change, possibly a surface-tension phenomenon, seems quite plausible when one considers the action of the sulphur granules in Hay's test for bile in urine.

A summary of a personal case of rupture of the gall-bladder with recovery follows: A twelve-year-old boy was seen in consultation with Dr. I. E. Ozanne, because of gradually increasing abdominal pain, one week after an auto injury. Examination revealed abdominal distention with shifting dullness, muscle spasm, but not board-like rigidity. The temperature was 98° F., pulse 84, respiration 24. The urine showed albumin, acetone and bile; leucocyte count was 27,000. A diagnosis of rupture of abdominal viscera was made. Under local anæsthesia a mid-line incision was followed by the escape of a large amount of bile-stained fluid. The viscera were bile-stained and œdematous, the gall-bladder ruptured. Abdominal drainage and enterostomy were done.

Twelve hours after operation the temperature went up to 101.2° F.; the next day it rose to 104° F. with corresponding increase in pulse rate. Thereafter the temperature rapidly declined and the patient made an uneventful recovery.

The vogue of omitting drainage after cholecystectomy has been followed, at times, by bile leakage into the peritoneal cavity, but high-temperature reactions are evidently rare, and secondary operation for drainage is usually followed by recovery.

It would seem that the above possibilities may be quite satisfactorily excluded as causative factors in these high-temperature fatalities. So-called liver "shock" and liver "insufficiency" call for serious consideration.

Cholæmia has been found so often to be in reality an uræmia that the name does not suggest a positive entity.

RAPID HIGH-TEMPERATURE DEATHS

Acute liver shock or insufficiency has been described as coming on within the first three post-operative days with high temperature, 104°–105° F.; pulse rapid, thready, 160–180; skin cold, moist; blood-pressure low, 60–80 systolic, which quite satisfactorily describes the cases here reported.

(The late or delayed shock is a gradual decline, usually after prolonged biliary drainage, and does not concern us here.)

The six- (or more) fold function of the liver and its remarkable recuperative power tend to make the explanation of hepatic insufficiency unsatisfactory. And the clinical picture of what, in reality, must be hepatic "insufficiency," namely, acute yellow atrophy, arsephamine jaundice, toxic-liver necrosis, and after-experimental hepatectomy—is strikingly dissimilar from this high-temperature syndrome.

In discussing this subject with surgeons, Stanton found such cases were not unknown, but that there were much confusion, differences of opinion and uncertainty regarding its cause or causes. Diseased or chemically altered liver-cells or bile, changed cholesterol metabolism, protein shock, allergy or anaphylaxis, injury to the nervous mechanism of the liver, or an overwhelming toxæmia have been offered as explanations, but the cause of death is frequently and honestly stated as "unknown" (as is stated by Petren in twelve of fifty-four deaths).

A similar temperature reaction is sometimes seen after fracture of the skull (A. O. Wilansky) due probably to mechanical injury to the heat centers of the brain. Manipulation of the largest abdominal organ, or traumatism to the abdominal ganglia (so-called "abdominal brain") of the visceral nervous system might theoretically be followed by disturbances in heat regulation. The fact that this syndrome appears not after extensive or complicated manœuvres with advanced diseased or degenerated structure, but after simple operations upon individuals in which local and general conditions are comparatively satisfactory, makes the acceptance of such an explanation difficult.

With our present information this condition must be looked upon as a chemical or metabolic reaction the nature of which is unknown.

In 1926, H. W. Cave⁴ reports three such cases in otherwise healthy women after calculous cholecystectomies, in which the operative procedures were easy and all were drained.

In 1930, E. McD. Stanton⁵ found two other cases in the literature and collected fifteen additional cases in hospital records, making a total of twenty in 500 deaths following biliary-tract surgery.

The lucid discussion and forceful presentation by Stanton crystalized the subject and brought to mind similar cases in my own experience and in that of my colleagues and prompted a review of the records of deaths following biliary-tract surgery at the Mercy Hospital, Oshkosh, 1925–1930. Number of operations, 549; number of deaths, 72 (13.1 per cent.); number of deaths within forty-eight hours with high temperature, 17.

Of these seventeen cases (23.6 per cent. of total number of deaths), the following facts were tabulated:*

Pre-operative.—Age incidence: Between twenty and thirty years, 3 cases; between thirty and forty years, 3 cases; between forty and fifty years, 3 cases; between fifty and sixty years, 5 cases; between sixty and seventy years, 3 cases. Female, 15; male, 2.

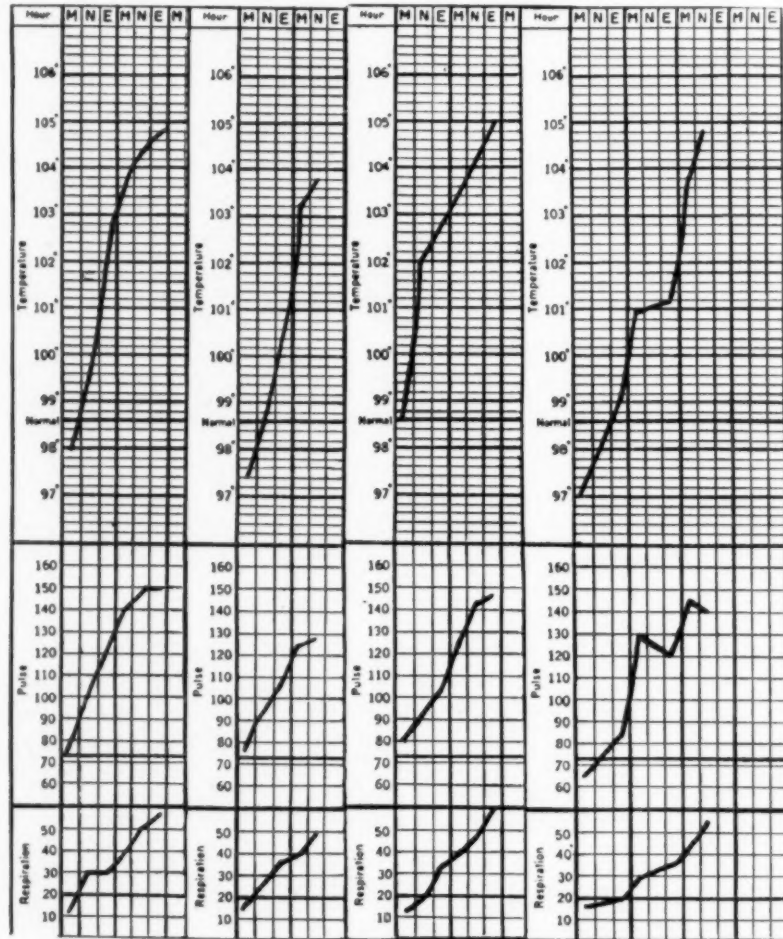


CHART 1.—Post-operative temperature charts. Typical of group.

Obesity, 6.
Jaundice, 6.
Thyroid enlargement, 6.
Pregnancies, 7.

Previous operations.—Two suspension of uterus and one subsequent laparotomy, for adhesions. Fibroid of uterus removed. Appendectomy and hysterectomy. Cholecystostomy twice.

* In the analysis of these case histories I was assisted by Dr. May Aileen Davies, of Madison, Wisconsin.

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Pre-operative Diagnosis.—Cholecystitis, calculous, 15; non-calculous, 2.

Additional Diagnosis.—Appendicitis, 6; goitre, 1; salpingitis, 1; myocarditis, 2.

Anæsthesia.—General, 13; spinal, 2; general and spinal, 1; general, spinal, local, 1.

Nature of Operation.—Cholecystectomy, calculous, 9; non-calculous, 4. Cholecystostomy, calculous, 4; non-calculous, 0. Choledochostomy in conjunction with above, calculous, 3; non-calculous, 1.

Additional Operative Procedures.—Appendectomy, 11; shortening of round ligaments and perineorrhaphy, 1.

Post-operative Diagnosis.—Cholecystitis, calculous, 13; non-calculous, 4.

Additional Post-operative Diagnosis.—Pancreatitis, 2; toxic goitre, 1; appendicitis, 4; retro-flexion of uterus, 1; myocarditis, 2; laceration of perineum, 1.

Immediate Post-operative Condition.—Good, 15; poor, 2.

Post-operative Course.—(See Chart 1.) Onset of temperature after return from operating room: In 15 within six to twelve hours; in 2 within twelve to eighteen hours.

Temperature.— 106° to 107° in 5; 105° to 106° in 4; 104° to 105° in 5; 103° to 104° in 1; 102° to 103° in 2.

Respiration "rapid," 17; chills, 0; vomiting, 6; "nervous symptoms," 17; delirium, 2; pulse: rapid, weak, 17; heart: "fibrillation," 1; "mitral systolic murmur," 1; "sounds weak and indistinct," 2; blood-pressure, hypertension in, 2; blood-count, white blood-cells above 10,000 in, 9; blood chemistry, N. P. N. 88.4; sugar, 196; milligrams 1; urine acetone, 10; sugar, 1; casts, 8.

Cause of Death (as Stated in Histories).—Unknown, 8; pneumonia and myocarditis, 1; pneumonia, 3; myocarditis, 5.

Autopsies were performed on two patients of the series with the following findings: (1) Soft spleen and liver, congestion of the kidneys, no evidence of peritonitis; (2) Consolidation of right lung, no evidence of peritonitis.

In two other cases post-mortem exploration of the abdomen through the operative incision satisfactorily excluded peritonitis and hæmorrhage as the cause of death.

Diagnosis.—In as much as these cases were all fatal, the diagnosis is automatic—in order to make the classification clean-cut we arbitrarily set forty-eight hours as a time limit. Cases living longer might possibly belong in this group but were not included.

Controls.—As clinical controls these same case histories in the 549 biliary-tract operations were again reviewed for similar post-operative temperature reactions in which the results were not fatal. Six such instances were collected but revealed no clue that might differentiate the fatal from the non-fatal cases.

As a second control, search was made, but none found, in which similar clinical findings were recorded after laparotomy in which the biliary tract was not interfered with.

Treatment.—In the absence of a known etiologic factor, treatment must, of course, be largely symptomatic.

In a review of the abortive cases (*i.e.*, in which symptoms start out similar to the fatal cases but rapidly subside and recovery takes place) the therapeutic attempts differ in no remarkable way from those employed in the less fortunate cases, and include the following measures:

Heat: to abdomen, light and diathermy; cold: ice-bag to head and precordia; rest, bromides, opiates; veratrum viride; gastric lavage; rectal feeding; proctoclysis: glucose, malted milk, normal saline, tap water; enteroclysis: glucose, normal saline; insulin; intravenous: glucose; sodium bicarbonate; normal saline solution; ringer's solution; digifolin—oxygen inhalation.

Because of a possible disturbance in the pancreatic function or in the glycogenic function of the liver, glucose, with or without insulin, has been given.

In this connection the following instance is of interest. Mrs. Wm. T. February 26, 1931, the second post-operative day was characterized by marked restlessness, apprehension, cyanosis, dyspnoea, vomiting, and temperature 102.2° F., pulse 126, respiration 36. Gastric lavage, dignifolin and glucose intravenous were ordered, and were followed by rapid subsidence of symptoms and in due time, recovery. On the next day it was discovered that, through a misunderstanding, a solution of sodium chloride had been given instead of glucose.

SUMMARY

1. Rapid high temperature deaths following biliary-tract operation are probably much more frequent than is indicated by the literature.
2. Such deaths have been confused with those due to: hæmorrhage, shock, cardiovascular, renal disease, hyperthyroidism, pulmonary disease or accident, acute gastric dilatation, septic peritonitis.
3. Bile "peritonitis," liver "shock" or liver "insufficiency" have been explained by: Diseased or chemically altered liver-cells or bile; changed cholesterol metabolism; protein shock, allergy or anaphylaxis; injury to the nervous mechanism of the liver; or an overwhelming toxæmia, but the signs and symptoms do not coincide with those of the cases under consideration.
4. With our present information, this rapid high-temperature death must be looked upon as a chemical or metabolic reaction, the nature of which is unknown.
5. In the literature, Stanton was able to collect twenty such cases.
6. At the Mercy Hospital (1925–1930) in seventy-two deaths following biliary-tract operation, seventeen (23.6 per cent.) could be grouped in this classification.
7. Pre-operative diagnoses, in addition to cholecystitis, were: Appendicitis, 6; goitre, 1; salpingitis, 1; myocarditis, 2.
8. Anæsthesia: General, 13; spinal, 2; general and spinal, 1; general, spinal and local, 1.
9. Nature of operation: Cholecystectomy, 13; cholecystostomy, 4. In addition: Choledochostomy in 4; appendectomy in 11; pelvic operation in 1.

RAPID HIGH-TEMPERATURE DEATHS

10. Post-operative diagnoses, in addition to cholecystitis: Pancreatitis, 2; toxic goitre, 1; appendicitis, 4; retroflexion of uterus, 1; myocarditis, 2; lacerated perineum, 1.

11. Post-operative temperature, 103° F. to 107° F.

12. Cause of death: Unknown, 8; pneumonia and myocarditis, 1; pneumonia, 3; myocarditis, 5.

13. Autopsies: Complete, 2; abdominal only, 2; peritonitis or hæmorrhage did not cause death.

14. In so-called abortive cases no distinctive findings were discovered.

15. As a control, search was made but none found in which similar clinical findings were recorded after laparotomy in which the biliary tract was not interfered with.

16. Treatment: Symptomatic. No difference in therapeutic effects between the fatal and non-fatal cases.

17. Stanton suggests a "clearing house" where records of these cases might be forwarded for classification and study. It is hereby suggested that Dr. E. McD. Stanton of Schenectady, N. Y., act in such a capacity and that reports be forwarded to him.

CONCLUSIONS

1. The fatal high-temperature reaction following biliary-tract surgery appears to be a definite clinical entity. Seventeen such cases occurring in seventy-two deaths after biliary-tract operations are analyzed.

2. It would seem rational to consider the syndrome as a metabolic, chemical or allergic reaction, or to a "nervous" phenomenon, the exact nature of which is unknown.

3. Instance of spontaneous recovery (what might be termed abortive) do occur but present no characteristic feature differentiating them from the fatal cases.

4. Treatment, in the absence of etiologic factor, is symptomatic. Therapeutic efforts in the "abortive" cases fail to give clue to effective treatment.

5. A review of post-operative records in laparotomies for conditions other than biliary-tract disease failed to show similar temperature reactions.

6. Further study, it is hoped, will clear up the subject and develop an effective therapy.

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CHOLECYSTOSTOMY*

WITH SPECIAL REFERENCE TO POST-OPERATIVE MORBIDITY AND FUNCTION

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IN RECENT years surgeons have become more and more inclined to broaden the indications for cholecystectomy, at the expense, so to speak, of operations for drainage of the gall-bladder. The result has been a gradual and definite increase in the percentage of cholecystectomies in operations performed for cholecystitis. Mentzer¹ quotes figures from the Mayo Clinic showing that in 1906, 55.7 per cent. of gall-bladder operations were cholecystostomies; in 1926, only 4.3 per cent. Figures vary from different clinics^{2,3} but certainly cholecystostomy is not performed with the same frequency as formerly.

The reason for the change in operative methods is obvious. Recurrence of symptoms sometimes necessitating secondary operation has forced surgical opinion to regard cholecystectomy as the operation of choice. Modern methods of preparation of the patient, newer types of anæsthesia, more thorough training of surgical personnel, and improved after-care of the patient have reduced the dangers from the operation for the removal of the gall-bladder and have made possible the more frequent extirpation of an obviously diseased and functionless viscus, which in earlier years would have been drained.

Although cholecystectomy is the operation of choice in the majority of cases of gall-bladder disease, cholecystostomy still retains a definite place in the list of operations performed for disease of the biliary tract. For this study we have selected the last 100 cases of cholecystostomy performed during the last seven years on Surgical Service C, at the University of Pennsylvania Hospital. In the last year, cholecystostomy has been performed in approximately 18 per cent. of the patients suffering from gall-bladder disease. These include all complications, such as pancreatitis, acute cholecystitis and poor surgical risks. When analyzed according to years it was noted that the percentage was much higher in the earlier years (38 per cent.), and fell considerably in the later years.

The indications for cholecystostomy may be divided conveniently into three groups: Group 1.—Cholecystitis with jaundice, with or without common-duct obstruction. Group 2.—Acute cholecystitis. Chronic cholecystitis in poor-risk patients. Group 3.—Patients with symptoms of gall-bladder disease, with or without stones, in whom the gall-bladder appears to be a functioning organ.

The first group, comprising patients with cholecystitis and jaundice, is agreed by most surgeons to be an indication for conservation of the gall-

* Read before the Philadelphia Academy of Surgery, April 6, 1931.

CHOLECYSTOSTOMY

bladder when possible. The jaundice may be due to calculous obstruction of the common duct, cholangitis, or lesions which obstruct the duct from without, such as inflammations and tumors of the pancreas or ampulla of Vater. In the cases with choledochus obstruction due to stone, the gall-bladder is drained because of the danger that the need for a secondary operation may, and very frequently does, arise. These operations are more easily and safely performed if the gall-bladder is present. Patients with cholecystitis and jaundice due to secondary cholangitis improve more rapidly and with less complications if prolonged drainage of bile to the surface is allowed to take place. When jaundice is due to chronic inflammatory processes in the pancreas, drainage of the gall-bladder improves the patient by relief of tension and drainage of the focus of infection, at the same time preserving the organ for use in secondary operation if the pancreatic lesion continues or increases. Cholecystostomy is performed in cases of jaundice from obstructions of the common duct due to disease of the head of the pancreas, strictures of the duct and ampulla lesions, only when an anastomosis of the gall-bladder with the stomach or duodenum cannot be performed. (Whether anastomosis or drainage is performed, the results of operation in this type of case are far from satisfactory.)

TABLE I
Results of Cholecystostomy in Cholecystitis with Jaundice

	Group I					
	No. of cases	Operative deaths	Return of symptoms	Secondary operation	No symptoms	Not followed
Cholecystitis with jaundice due to common-duct stone (cholecystostomy, choledochostomy).....	18	4	2	2	11*	1
Cholecystitis with jaundice due to cholangitis, cirrhosis or chronic pancreatitis (cholecystostomy with or without choledochostomy).....	11	2	3	3	5†	1
	29	6‡	5	5	16	2

* One, 1 year; two, 2 years; two, 3 years; two, 5 years; two, 6 years; two died of intercurrent disease.

† Two, 1 year; one, 3 years; two, 4 years.

‡ 20.7 per cent.

In this series are twenty-nine cases which fall into this group. (See Table I.) Of these, eighteen cases had jaundice due to calculous obstruction of the common bile-duct. These patients were treated by cholecystostomy and choledochostomy. There were four operative deaths—22.2 per cent. In thirteen of the surviving cases, the end-results are known. Two of these had a recurrence of symptoms necessitating operation—15.4 per cent. Eleven cases have had no return of symptoms in one to six years—84.6 per cent. of the surviving cases.

Eleven patients in this group had jaundice due to secondary cholangitis,

cirrhosis, or chronic pancreatitis, most of whom were treated by choledochostomy or choledochotomy in addition to cholecystostomy. There were two operative deaths—18.8 per cent. Eight of the surviving cases have been followed. Three (37.5 per cent.) had a return of their previous symptoms requiring operation. In the remaining five patients there has been no return of symptoms in one to four years.

Taking the jaundice group as a whole, the operative mortality was 20.7 per cent., a recurrence of symptoms occurred in 23.4 per cent. of the surviving cases, and 76.6 per cent. were clinically cured. Of the five cases in whom secondary operations were performed, stones were found in three.

The second group of indications for cholecystostomy includes those cases where acute or chronic cholecystitis is associated with some acute local or chronic systemic disease; in other words, in patients on whom the surgeon is afraid to risk the more difficult and radical operation of cholecystectomy. "It is better, in the occasional case, to perform cholecystostomy with the possibility of having to reoperate, than to risk losing the patient with a more radical operation." (W. J. Mayo.)

TABLE II
Results of Cholecystostomy in Acute and Chronic Cholecystitis without Jaundice

	Group 2					
	No. of cases	Operative deaths	Return of symptoms	Secondary operations	No symptoms	Not followed
Acute cholecystitis.....	39	1	7*	1	26†	5
Chronic cholecystitis in poor-risk patients.....	10		3		5‡	2
	49	1	10	3	31	7

* Two with carcinoma of biliary tract.

† One, 1 year; four, 2 years; four, 3 years; seven, 4 years; five, 5 years; one, 7 years; two died of intercurrent disease.

‡ Three, 4 years; two died of intercurrent disease.

The indications for cholecystostomy are not always clear cut in the cases in this group and often depend upon the experience, judgment and skill of the surgeon and his staff, as well as on the patient's condition. Forty-nine of the cases fall in this group. (See Table II.) The larger part of the group (thirty-nine cases) were patients with acute cholecystitis. In all such cases, when possible, operation is delayed until the acute symptoms subside. When, however, the acute symptoms continue or increase in severity, or when signs appear of extension of the inflammatory process to the pancreas, or when there are symptoms of respiratory or cardiac embarrassment, it has been the practice in this clinic to perform a cholecystostomy even in the acute stage.

Most of these patients were considered poor operative risks for various reasons. Age (five cases) or serious cardiac or pulmonary disease (five cases) were factors in some instances. In the majority of patients (twenty cases) the extent of the local inflammatory process was such that the patient was acutely ill and any but the simplest and shortest operation would have

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exhibited poor surgical judgment. Included in this category are those cases of acute pancreatitis without jaundice, and many cases of empyæma and beginning gangrene of the gall-bladder. Finally, there is a group of patients who become poor operative risks because of technical difficulties (nine cases). Patients in whom exposure is embarrassing due to marked adiposity or inexperienced assistance, in whom structures are hidden in a mass of inflammatory œdema, are often better treated by conservative drainage than by risking the dangers and difficulties of cholecystectomy. It is in this group of cases that the mature judgment of the experienced surgeon is necessary for the best results. The younger operator often has a tendency to attempt too much.

Of these thirty-nine patients there was one operative death (2.8 per cent.), a case of acute cholecystitis complicated by hæmorrhagic pancreatitis. Follow-up results have been obtained in thirty-three of the remaining cases. A return of symptoms occurred in seven patients, 21.2 per cent., two secondary operations were performed, stones were found in only one of these. No further symptoms developed in twenty-six cases, 78.8 per cent. of the surviving cases.

Cholecystostomy was performed for chronic cholecystitis in ten poor-risk patients. Patients with chronic gall-bladder disease are placed in this group because of grave cardiac or other serious constitutional disease. Those past the sixth decade of life, especially if they are fat, are often best treated by cholecystostomy. A few younger patients are placed in this group at the time of operation because of anæsthetic or technical difficulties.

There were ten patients in this group with no operative deaths. Eight of these were followed, and of these three showed a return of symptoms (37.5 per cent.), none of whom have been operated upon. Five had no return of symptoms due to gall-bladder disease—62.5 per cent.

The third indication for cholecystostomy arises in those cases where symptoms of gall-bladder disease occur in patients in whom the gall-bladder, either with or without stones, appears to be a functioning organ—(twenty-two cases). By simple external inspection and palpation of the gall-bladder it is impossible to accurately diagnose the presence or absence of stones, in some cases. It has been the practice in this clinic, therefore, to open every normal-appearing gall-bladder when clinical symptoms suggest cholecystitis. The entire mucosa is then inspected by direct vision through the cholecystoscope devised by the authors.⁴ After removal of all stones, a tube is sutured in the opening into the gall-bladder. In an occasional case the gall-bladder has been closed without drainage.

This indication for cholecystostomy may be contested by many surgeons, but the position is held on the following physiologic grounds. Bile has been shown by Mellanby⁵ to play the chief rôle in the digestion and absorption of fats. Conversely, clinical and experimental⁶ findings prove that in the absence of bile, fat absorption is greatly diminished. Mellanby⁷ further demonstrated experimentally that the absorption of bile from the duodenum acts as the maximal alimentary stimulus for pancreatic secretion. Bile, then,

appears to play an important and direct part in the digestion and absorption of fat, and an indirect one, by influencing pancreatic secretion, in the digestion of other food constituents.

The gall-bladder plays a fairly important rôle in the physiology of digestion. Its functions, according to modern physiologists,⁸ are: (a) Storage and concentration of bile during fasting; and (b) emptying of stored bile into the duodenum during digestion, especially of fats, by muscular action. On the presence of a functioning gall-bladder, then, depends in large measure the action of bile in digestion, because the amount which can enter the duodenum from the liver and normal common duct is small in comparison.

These functions of the gall-bladder are of enough importance to warrant its preservation. "The fact that its absence is tolerated," in Wilkie's opinion,⁹ "is no argument against the importance of its function; it is merely a tribute to nature's powers of compensation." The compensatory changes which occur following loss of gall-bladder function, either by chronic disease or by cholecystectomy, have been observed by many.^{9,10} There is usually a gradual dilatation of the bile-ducts and after cholecystectomy often a dilatation of the stump of the cystic duct to form a new miniature gall-bladder. This is nature's effort to replace the storage function of the gall-bladder. In addition, Sutton¹¹ has recently shown experimentally that the bile-duct epithelium undergoes changes of adaption to assume the function normally performed by the gall-bladder.

These changes require time, and we have noted that removal of a normal-appearing and supposedly functioning gall-bladder is often followed by a period in which there are nausea and epigastric distress, especially following the ingestion of fatty foods.⁴ McKenty¹² has noted that the full benefit of cholecystectomy is sometimes delayed for more than a year after operation—presumably due to the fact that gradual compensatory dilatation of the ducts is necessary before approximately normal function can take place.

In this series, the state of gall-bladder function was judged by two methods:

(a) Examination of the gall-bladder at operation.

A gall-bladder of translucent, cerulian blue, not indurated, without lymphadenitis or adhesions, with a common duct of normal size, was judged to be a functioning organ, even if it contained one or several stones.

(b) Cholecystographic evidence of gall-bladder function.

The Graham-Cole method of testing gall-bladder function determines its ability to concentrate the dye and to empty it in response to a fatty meal—which functions may be normally preserved even in the presence of stones.¹³

In this group are twenty-two cases of our series. (See Table III.) Eight of these gave symptoms of apparent gall-bladder disease, but at operation the gall-bladder appeared normal in color and texture and contained no stones. In two of these the gall-bladder had functioned normally when examined by X-ray and one showed a non-functioning gall-bladder when the dye was given by the oral method. There was one death, one week after

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TABLE III

Results of Cholecystostomy, Where the Gall-bladder Was Apparently a Functioning Organ

	No. of cases	Operative death	Return of symptoms	Secondary operations	No symptoms	Not followed
Normal - appearing gall-bladder, no stones.....	8	1			6*	1
Normal - appearing gall-bladder with stones.....	14		5	2	9†	
	22	1	5	2	15	1

* One, 2 years; two, 3 years; two, 4 years; one, 5 years.

† One, 2 years; two, 3 years; three, 4 years; three, 6 years.

discharge from the hospital, of a patient who also had a gastric operation, and later developed a bronchopneumonia. Six of the remaining cases have been followed, all of whom are without symptoms from two to five years.

There were fourteen cases in which the gall-bladder appeared normal but contained stones. Of these there was a return of symptoms in five cases, 35.7 per cent., and in two of them a secondary operation was performed for the removal of stones. In nine cases, 64.3 per cent., the patients have been relieved of symptoms from two to six years.

Hernia.—In the seventy-nine cases followed, there were five (6.3 per cent.) which showed the development of incisional hernia. Four of these occurred through a transverse incision, one through a paramedian incision. All of them appeared at the site of the drainage tube.

Summary of results.—In 100 cases in which cholecystostomy was performed, there were eight operative deaths (8 per cent.) Six of these occurred in patients with jaundice in whom choledochostomy was also performed, and one in a patient who had also a gastric operation, so that the operative mortality from cholecystostomy alone was 1 per cent. End-results were obtained in seventy-nine patients. Of these, twenty-one (26.6 per cent.) had a return of symptoms. Secondary operations were performed in ten cases, 12.6 per cent. of the cases followed. Stones were found at the secondary operation in six cases—7.6 per cent. In fifty-eight cases (73.4 per cent.) there was a relief of all symptoms of gall-bladder disease.

Incisional hernia occurred in five cases—6.3 per cent. of the followed patients.

Cholecystographic Studies of Gall-bladder Function after Cholecystostomy.—As more and more trustworthy evidence accumulates indicating definite physiologic functions of the gall-bladder, it becomes more interesting to determine whether function can be recovered after drainage of the organ.

There are two factors involved: First, does simple drainage of the organ interfere with its subsequent activity; and second, does cholecystostomy in a gall-bladder, the seat of an acute or chronic inflammation, bring about a recovery sufficient to allow a return of function?

Spurling and Whitaker,¹⁴ in 1927, studied by cholecystogram twelve cases of acute or chronic gall-bladder disease treated by cholecystostomy. None of

them showed a normally functioning gall-bladder, from twenty-five days to nineteen years after operation, and they concluded that "drainage of a diseased gall-bladder, with the expectation that it will regain its normal function, is not only a futile procedure but one that endangers the future health of the patient."

They have thus answered question two in the negative. Our study was made on twenty patients in a similar manner and with nearly similar results. The dye, sodium tetraiodophenolphthalein, was administered by the oral method in all cases and in a few the findings were confirmed by the intravenous technic.* Table IV gives a summary of these cases, all of whom had definite disease of the gall-bladder as noted at operation. The first five cases belonged to the group of cholecystitis with jaundice. One of these (Case II) showed a normally functioning gall-bladder two years following cholecystostomy and choledochostomy. The gall-bladder was not visualized in any of the other patients.

TABLE IV

CASE I.—Female, aged forty years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Gall-bladder small. Stones in common duct and gall-bladder. Time since gall-bladder drainage.—Two years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—Indigestion only if fatty foods are eaten. Operative findings secondary operation.—None.

CASE II.—Male, aged fifty-three years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Gall-bladder distended. Stones in gall-bladder and common duct. Time since gall-bladder drainage.—Two years. Post-operative X-ray diagnosis.—Normally functioning gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE III.—Female, aged forty-nine years. Pre-operative X-ray diagnosis.—Gall-bladder shadow faint. Poor concentration and emptying. Operative diagnosis and findings.—Gall-bladder thick. Stones in gall-bladder and common duct. Time since gall-bladder drainage.—Two years. Post-operative X-ray diagnosis.—Non-functioning gall-bladder. Symptoms since cholecystostomy.—Pain in right upper quadrant. Distention. Operative findings secondary operation.—Gall-bladder thick. Many stones.

CASE IV.—Female, aged forty-two years. Pre-operative X-ray diagnosis.—Gall-bladder not visualized. Operative diagnosis and findings.—Thick gall-bladder. Many adhesions. No stones. Time since gall-bladder drainage.—Four years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms. Small hernia. Operative findings secondary operation.—None.

CASE V.—Female, aged forty years. Pre-operative X-ray diagnosis.—Gall-bladder not visualized. Operative diagnosis and findings.—Ulcers of mucosa. Three stones. Time since gall-bladder drainage.—One year. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—Slight jaundice. Tenderness over gall-bladder. Operative findings secondary operation.—No stones. Gall-bladder thick. Ulcers of mucosa.

CASE VI.—Female, aged fifty-six years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Acute cholecystitis. Four large stones. Time since gall-bladder drainage.—Six years. Post-operative X-ray diagnosis.—No visualization of

* A personal communication to the authors from Dr. E. P. Pendergrass, of the Röntgen Department, University Hospital, was to the effect that practically as good results have been obtained by the oral as by the intravenous method of giving the dye.

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gall-bladder. Symptoms since cholecystostomy.—Many attacks of gall-bladder pain. Operative findings secondary operation.—None.

CASE VII.—Male, aged fifty-eight years. Pre-operative X-ray diagnosis.—Empyæma of gall-bladder. One large stone. Time since gall-bladder drainage.—Five years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE VIII.—Female, aged sixty-nine years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Hydrops with beginning gangrene of gall-bladder. Two large stones. Time since gall-bladder drainage.—Two years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE IX.—Female, aged forty-seven years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Acute cholecystitis. Two large stones. Time since gall-bladder drainage.—Two years. Post-operative X-ray diagnosis.—Faint shadow. Impaired function. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE X.—Female, aged sixty-seven years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Acute cholecystitis. Many stones. Time since gall-bladder drainage.—Five years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—Several attacks of biliary colic. Operative findings secondary operation.—None.

CASE XI.—Female, aged thirty-nine years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Acute cholecystitis. Many stones. Time since gall-bladder drainage.—Five years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE XII.—Female, aged sixty years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Gall-bladder thick. Five small stones. Chronic pancreatitis. Time since gall-bladder drainage.—Seven years. Post-operative X-ray diagnosis.—Faint shadow. Impaired function. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE XIII.—Female, aged fifty-two years. Pre-operative X-ray diagnosis.—Flat plate. Negative for stones. Operative diagnosis and findings.—Gall-bladder thick. Tense. Many stones. Pancreatitis. Time since gall-bladder drainage.—Eighteen months. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms on careful diet. Operative findings secondary operation.—None.

CASE XIV.—Female, aged fifty-three years. Pre-operative X-ray diagnosis.—Normally functioning gall-bladder. Operative diagnosis and findings.—Acute cholecystitis and pancreatitis stones. Time since gall-bladder drainage.—Five years. Post-operative X-ray diagnosis.—Faint shadow. Impaired function. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE XV.—Male, aged forty-two years. Pre-operative X-ray diagnosis.—Gall-bladder not visualized. Operative diagnosis and findings.—Hydrops with gangrenous spots in gall-bladder wall. Edema of pancreas. Time since gall-bladder drainage.—One year. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE XVI.—Male, aged fifty-eight years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Hydrops of gall-bladder. One stone. Time since gall-bladder drainage.—Five years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE XVII.—Male, aged twelve years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Hydrops. Sixty small stones. Time since gall-

bladder drainage.—Four years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—Occasional soreness in right upper abdomen. Operative findings secondary operation.—None.

CASE XVIII.—Female, aged thirty-one years. Pre-operative X-ray diagnosis.—Gall-bladder not visualized. Operative diagnosis and findings.—Gall-bladder contracted. Thick. Many stones. Time since gall-bladder drainage.—Two years. Post-operative X-ray diagnosis.—No visualization of gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE XIX.—Male, aged forty-five years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Thick œdematous gall-bladder. One stone. Time since gall-bladder drainage.—Five years. Post-operative X-ray diagnosis.—Faint shadow. Impaired function. Symptoms since cholecystostomy.—No symptoms. Small hernia. Operative findings secondary operation.—None.

CASE XX.—Female, aged forty-six years. Non-functioning gall-bladder. Operative diagnosis and findings.—Gall-bladder thick. No stone. Time since gall-bladder drainage.—Five years. Post-operative X-ray diagnosis.—No visualization. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

Cases VI to XV represent patients with acute or chronic gall-bladder disease, who were considered too poor operative risks for cholecystectomy. Not one of these patients was found to have a gall-bladder which functions normally, yet only three of these fifteen patients have noted a return of gall-bladder symptoms.

Our findings, then, coincide with those of Spurling and Whitaker in nineteen out of the twenty cases, *viz.*, that drainage of an obviously diseased gall-bladder does not bring about a return of normal function, at least in so far as can be determined by the cholecystogram.

In answer to the first question, does drainage of the normal gall-bladder interfere with its subsequent activity, eight cases are presented in whom the gall-bladder appeared normal at operation, and gave every indication of being a functioning organ. The gall-bladder was opened in these cases for purposes of diagnosis and in the last five cases for the removal of stones.

TABLE V

CASE I.—Female, aged fifty years. Pre-operative X-ray diagnosis.—Normal gall-bladder. Operative diagnosis and findings.—Normal gall-bladder. One adhesion. No stones. Time since gall-bladder drainage.—Four years. Post-operative X-ray diagnosis.—Normally functioning gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE II.—Female, aged forty-three years. Pre-operative X-ray diagnosis.—Border-line gall-bladder. Large gall-bladder. Poor emptying. Operative diagnosis and findings.—Normal-appearing gall-bladder. Large. Few adhesions. No stones. Time since gall-bladder drainage.—Four years. Post-operative X-ray diagnosis.—Normally functioning gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE III.—Female, aged thirty-three years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Normal-appearing gall-bladder. No stones. Time since gall-bladder drainage.—Two years. Post-operative X-ray diagnosis.—Normally functioning gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE IV.—Male, aged fifty years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Normal gall-bladder. Several small stones. Time since

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gall-bladder drainage.—Six years. Post-operative X-ray diagnosis.—Normally functioning gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE V.—Female, aged fifty-two years. Pre-operative X-ray diagnosis.—Stones in gall-bladder. Operative diagnosis and findings.—Normal-appearing gall-bladder. One stone, strawberry type. Time since gall-bladder drainage.—Four years. Post-operative X-ray diagnosis.—Normally functioning gall-bladder. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.

CASE VI.—Female, aged twenty-seven years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Normal-appearing gall-bladder. Several stones. Time since gall-bladder drainage.—Six years. Post-operative X-ray diagnosis.—Border-line gall-bladder. Visible in first film. Concentrated poorly. Empties normally. Symptoms since cholecystostomy.—Two attacks of right upper quadrant pain following two pregnancies. Operative findings secondary operation.—None.

CASE VII.—Female, aged fifty-one years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Normal-appearing gall-bladder. Strawberry mucosa. One stone. Time since gall-bladder drainage.—Three years. Post-operative X-ray diagnosis.—Impaired function. Faint visualization. Symptoms since cholecystostomy.—No symptoms. Operative findings secondary operation.—None.

CASE VIII.—Female, aged thirty-seven years. Pre-operative X-ray diagnosis.—None. Operative diagnosis and findings.—Normal color gall-bladder. Distended. Stones. Time since gall-bladder drainage.—Six years. Post-operative X-ray diagnosis.—Impaired function. Symptoms since cholecystostomy.—Return of gall-bladder pains. Operative findings secondary operation.—Stones. Adhesions.

The results are tabulated in Table V. In the first three cases, in which no stones were found, all of the patients showed a normally functioning gall-bladder two or more years after cholecystostomy, and they are symptom-free. Of the last five cases, from whom stones were removed, two showed a gall-bladder of normal function and were without symptoms. The cholecystogram in one patient was reported as "border-line function." This patient has had attacks of right upper quadrant pain after each of two pregnancies. The last two patients showed definite impairment of function by cholecystogram, one of these has had no subsequent symptoms, the other was reoperated upon six years after the primary operation, because of a return of gall-bladder symptoms. Stones and pericholecystitic adhesions were found.

Because of the relatively small series of cases it is rather dangerous to generalize concerning results. It is permissible, however, to say that the operation of drainage of the gall-bladder may be followed by recovery of normal function. We believe, then, that recovery or disturbance of function following cholecystostomy depends entirely upon the condition of the gall-bladder itself. If the gall-bladder is obviously diseased, with thickened walls and infected mucosa, a return of normal function is hardly to be expected from cholecystostomy. Normal-appearing and supposedly functioning gall-bladders may be expected to retain their function following cholecystostomy, less commonly, however, when stones were present at the primary operation.

CONCLUSIONS

A follow-up cholecystogram study was made on twenty-eight patients one or more years after cholecystostomy.

In only one out of twenty cases, where the operative findings showed evident cholecystitis, was there a normally functioning gall-bladder as shown by cholecystogram. These findings confirm those previously published by Spurling and Whitaker.

Eight cases were studied in which the gall-bladder appeared normal at operation. Five of these cases showed normal gall-bladder function, three non-calculous and two stone cases. In three cases, in which stones were removed at the primary operation, impaired function was noted by cholecystogram.

Gall-bladder function which was lost before operation cannot be recovered following cholecystostomy. Those which function normally before operation may retain their function after cholecystostomy.

The operation of cholecystostomy *per se* does not greatly disturb subsequent gall-bladder function.

The authors desire to express thanks to the Social Service department for aid in obtaining follow-up observations on many of these patients and to the X-ray department of the University Hospital for their coöperation in making the post-operative cholecystograms.

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CANCER OF THE UTERUS*

WITH GENERAL REMARKS ON THE PATHOLOGIC ASPECTS OF CANCER OF THE UTERUS

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THE general surgeon's viewpoint of cancer of the uterus is somewhat different from that of the specialist in diseases of women. This is only natural since the general surgeon deals with cancerous conditions in every part of the body and should be better able to evaluate the ravages of this dread disease wherever it occurs.

Cancer of the uterus is a disease of middle life but may occur earlier or later. It constitutes about one-third of all kinds of cancers in women, and nearly 90 per cent. of uterine cancers originate in the cervix. We rarely see cases of cervical cancer before ulceration has extended into the deeper tissues of the cervix. Clinically, I divide cancer of the cervix into three groups: The operable, questionably operable, and non-operable. The operable group includes those where the cervix is hard or nodular, perhaps enlarged, and where the tissues are friable, but there is as yet no evidence of ulceration or metastasis. In the very early case, usually one or more nodules can be felt. These constitute the most favorable cases for complete hysterectomy with removal of the glands. The operative mortality is very low in this group. Where there is ulceration of the cervix with exuberant granulations which bleed freely to the slightest touch and there is no palpatory infiltration in the broad ligaments, we introduce radium and later make a complete abdominal removal, including the uterine appendages, with excision of the glands. We class this type of case as questionably operable. By careful anatomic dissection of the glands these patients usually present a fairly good temporary outlook. Sooner or later, however, the larger percentage of them return with involvement of the broad ligaments, when we advise deep X-ray treatment, but, in our experience, with little if any benefit.

Where the entire vaginal cervix is diseased, it is our practice to treat by radium and deep X-ray therapy. These patients improve locally, but all eventually die of the disease. This is anything but a favorable showing. I personally believe that the future of these patients can be made brighter only by earlier recognition and radical operation. I can liken this condition to carcinoma of the breast, in that radical operation promises much if done while the disease is local.

Cancer of the cervix is most often of the squamous-cell (epidermoid) variety. Very early it appears as a hard nodule. Squamous-cell carcinoma

* Read before the Philadelphia Academy of Surgery, April 6 1931.

ulcerates early and produces a bloody, stinking discharge. In the late case of this variety of carcinoma, not infrequently there are exuberant granulations forming the so-called cauliflower growth.

Adeno-carcinoma, on the other hand, is less frequent, is hard to the touch, and ulcerates much later than does the squamous-cell carcinoma. Early cancer originating within the cervical canal, as one can readily understand, is more likely to be overlooked than cancer of the vaginal surface of the cervix, therefore when in doubt the cervix should be split and the canal inspected, when the diagnosis is readily made.

Operable carcinoma of the cervix comprises the group where at best one can say the cervix only is involved. Where there is invasion of the surrounding vaginal walls or the vesico-cervical parametrium, operation promises nothing in the way of cure.

With the abdomen opened, and a wide exposure, one can decide this question. As far as I am able to say, in border-line cases, nothing other than this can definitely settle the question. I do not think operation should be made indiscriminately, nor radium or X-ray administered until the most careful and painstaking examination has been made by the surgeon, but I fear that too often the treatment is determined by the doctor and the radiologist or the röntgenologist. I cannot think this is the best for the patient any more than I think that the operating surgeon is as well fitted to determine the proper dosage of radium or X-ray as is the radiologist or the röntgenologist.

Carcinoma of the body of the uterus is a different proposition from carcinoma of the cervix, in that it occurs much less frequently (in only about 10 per cent. of the cases) and has not the same high mortality. The diagnosis, however, is less certain on account of many other conditions that may simulate it and, like carcinoma of the cervix, it is not visible to the eye. Bleeding from the uterus in a woman of cancer age and beyond the menopause, with no evidence of disease of the cervix and in the absence of an enlarged uterus, should make one think of cancer. The appearance of the cervix, if enlarged, and if it bleeds upon manipulation or the introduction of a sound, should suggest the possibility of endocervical or fundal carcinoma. Submucous fibroid, hæmorrhagic endometritis, polypoid endometritis and essential hæmorrhage with anæmia are conditions to be borne in mind in making the diagnosis. Diagnostic curettage and microscopic examination of the scrapings should be made in doubtful cases. Carcinoma of the body of the uterus, especially fundal carcinoma, rarely bleeds as freely as a submucous fibroid, hæmorrhagic endometritis, or polypoid endometritis. Spotting is one sign of carcinoma and calls for immediate investigation. With the abdomen open, if there is still doubt, hysterotomy and careful examination will solve the riddle. Many of my gynecologic friends know my fondness for the latter operation, which, while they do not approve of it, has given me more satisfaction and enlightenment than almost any other operation made upon the uterus. One of the strongest arguments in its favor is that it has practically no mortality, dispels doubt, and reveals the truth. I take it there is no difference of opinion with re-

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gard to the wisdom of complete removal of the uterus for fundal carcinoma.

The choice of operation, whether vaginal or abdominal, will depend upon the condition and the size of the patient, the size of the uterus and the roominess of the vagina. Where feasible, I prefer the vaginal operation, as it is a shorter procedure than abdominal hysterectomy, is attended by less risk and has a shorter convalescence. If the dissection is carefully made, there is little or no danger of injuring the ureters. I see no particular objection to the introduction of ureteral catheters to avoid injuring the ureters if the surgeon so prefers, but this is not my practice, nor do I use clamps except in very obese patients with a large uterus.

In abdominal hysterectomy it is my practice as a rule to expose the ureters. This is easily done and without additional risk. The first question I ask, however, when seeing the patient the morning following the operation is how much urine has she passed and what is its color.

In discussing the subject of cancer of the uterus, one is confronted with the same problems as pertain to cancer in general. The prime consideration is, how to get our cases early enough to make cure more promising. This is essential for success in the campaign for the control of cancer. As applied to the uterus, this means early attention to so common a lesion as laceration of the cervix, as well as erosion, hypertrophic and hæmorrhagic endometritis, chronic cervicitis, polyp, and any unusual discharge during or following the menopause. Statistics agree that the majority of women with cancer of the cervix have borne children and although aware of the laceration so often incident to childbirth, they wait until the approach of the menopause or even beyond that time to have the lesion repaired. Immediate repair under hospital conditions would be a great help in reducing the incidence of cancer of the uterus. The matter is one of education both of the laity and the profession. Our women must be taught to seek advice for any abnormal vaginal discharge, either during active menstrual life or after the menopause. Our doctors must be educated to give such conditions as laceration, erosion, endometritis, polyp, *etc.*, all the serious and earnest attention they demand. Erosion is nearly always associated with laceration and erosion may be the starting point of ulceration and malignant change. At present that is about all we definitely know as to the etiology of cancer, that is, these lacerations and erosions lead to irritation and irritation is the basis of cancer. "Long-continued irritation and chronic inflammation are probably the conditions which pave the way for the development of the new growth." (Polak.)

The theory of precancerous lesions has its advocates and opponents among pathologists, according to what may be termed their individual creed. There are those who believe that cancer, that is to say, the first tumor cell (or cells) arises suddenly. Naturally the adherents of this creed believe that there is no such thing as a precancerous lesion. The tumor either is not cancer or is cancer from the very outset. On the other hand, for those who believe that cancer develops as the result of a gradual process of cellular changes, the precancerous lesion is a live issue, more in accord with our present knowl-

edge of tumor growth. If clinical evidence were not sufficiently reliable to support this latter theory, it certainly can be maintained on the strength of histologic studies. I need but refer to clinical cases of leucoplakia of the tongue or buccal mucous membrane that show cancerous transition in which sections of tumor show at their periphery tumor cells encroaching upon the leucoplakia epithelium. According to some observers a similar leucoplakia of the cervical mucosa is demonstrable with the aid of the colposcope, indicating at first more or less slowly progressing change from normal to pathologic tissue, the first abnormality being a leucoplakia and the last one cancer. The logical conclusion from these observations would be for all women to undergo periodic vaginal examinations in order to forestall any potentially malignant change. This would represent the ideal we are striving for—prevention. Unfortunately, we do not get the cases early. This is all the more regrettable inasmuch as the victims so often are in the prime of life and are snatched away from their families at a time when the maternal influence is so essential for the training of the adolescent youth.

Opinions are divided as to the virtues of surgery as compared with radiation. Unfortunately, Curie therapy is not as yet synonymous with cure, and neither the radiologist nor the röntgenologist nor the surgeon can claim very brilliant results. The gist of the matter is that we are still floundering. However, a recent survey of end-results of 140 cases in the Lankenau Clinic from October, 1920, to January, 1929, shows that the expectancy of life after operation is somewhat better than after radiation or X-ray alone.

The mortality of the entire group during the nine years was 57.8 per cent. Eighty-three received radium only. This group shows the highest mortality—(70 per cent.); eighteen were treated by operation and radium; ten of these died, showing a mortality of 55 per cent., while the thirty-nine treated by operation alone gave a mortality of 33.3 per cent.

On the other hand, in view of the fact that many cases are already hopeless when first seen, radium treatment is less distressing than operation and provides temporary improvement. I would say that radium is of value also not only in bringing some cases to a state of operability, as referred to previously, but that it is especially valuable for those whose general condition, age, *etc.*, forbid radical surgery. Furthermore, if and when it cures, it does so without mutilation, a fact of especial importance to the younger patients.

Opinions seem to agree that radium and X-ray give the best results in squamous-cell carcinoma, but not in the pearly body squamous-cell carcinoma. The type of tumor in the above series was: squamous-cell carcinoma, 33; cylindrical cell, 2; adenocarcinoma, 25; no pathologic diagnosis, 80.

Of the squamous-cell carcinomas, nineteen were treated by operation, four of which were also given radium. Of the fifteen four were living and well at the end of the period of this investigation; three living with metastasis; one living with a vesico-vaginal fistula; one living and well at twenty-seven months, then lost sight of; and six were dead.

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Of the four given radium, one received radium both before and after operation. She was living and well seventy-seven months without evidence of further recurrence. One received radium before operation and was living and well at seventy-two months after operation. One received radium for metastasis in the broad ligament twenty-two months after hysterectomy and died one month after radium treatment. The other case was lost track of.

In the operative cases the operation consisted of complete hysterectomy, 7; living and well, 3 (twenty-four, sixty-six, seventy-seven months); died, 4 (three, three, twenty-two, twenty-three months later). Complete hysterectomy and bilateral salpingo-oophorectomy, 6; living and well, 1 (fifteen months); living with metastasis, 3 (seventeen, seventeen, seventy-two months); living with a vesico-vaginal fistula, 1 (twenty-seven months); died, 1 (seven months after operation.) Vaginal hysterectomy, 1; died twenty-two months later. Exploratory, 1 (died fourteen months later).

Of the fourteen cases of squamous-cell carcinoma given radium alone, thirteen died in from eight to eighty-four months. One had a vesico-vaginal fistula, but otherwise did fairly well for sixty-two months, then developed intestinal symptoms and was bedridden until death at eighty-four months. Another case, after the first application of radium, was free from symptoms for fifty months, then developed bleeding, had a second application at fifty-two months and died at fifty-three months.

Both cases of cylindrical-cell carcinoma were operated upon and one in addition received radium post-operatively. The case of subtotal hysterectomy with removal of both tubes and ovaries was living three months after operation, after which time she could not be traced. The other had subtotal hysterectomy and received radium after the operation; died in eleven months.

Adeno-carcinoma (Twenty-five Cases).—All were treated surgically, three had post-operative X-ray treatment. The operative procedure was: Complete hysterectomy with removal of both tubes and ovaries, in 14; nine living and well from five to twenty-seven months. Complete hysterectomy, 6; five living and well from sixteen to seventy-five months, and one dead at six months. Supravaginal amputation (subtotal hysterectomy) with bilateral salpingo-oophorectomy, 1, well sixty-six months later. Supravaginal amputation (subtotal hysterectomy) 2, both living and well twenty-four months later. One, dilatation and curettage only, living and well at forty-eight months. One (inoperable) had an exploratory incision and died in eleven months.

I give these figures for what they are worth. I would add that our experience with X-ray therapy and radium has not given the results claimed by many. We have never seen adeno-carcinoma cured, either by X-ray or radium. In the cases that have advanced to the stage of infiltration of the broad ligaments we have never seen any results such as dissipation of the infiltrate either with deep X-ray therapy or radium, although palliation—less pain—has followed deep X-ray therapy, in some but not in all cases thus treated.

There are two or three points that I would like to touch upon briefly.

The one is diagnostic curettage. A number of clinicians object to diagnostic curettage because of the danger of disseminating cancer cells in case the condition is malignant. I cannot agree with them. Another is the question of glandular involvement as affecting end-results. It is only by study of glandular involvement that the comparison of results of the two forms of treatment would be valid; and finally let me call attention to one item that acts to the detriment of both forms of treatment. I refer to the fact that surgery is often performed by the unskilled operator and radium is used by men without the special experience and knowledge required for the proper selection of cases. There is no way to remedy these facts except by education and propaganda.

In the question of prognosis great stress is now being laid on the grading of tumors according to their degree of malignancy. This is so essentially the province of the pathologist that I have asked Doctor Reimann to provide some thoughts on the subject, which he has kindly consented to do. Doctor Reimann says: Hardly any discussion of malignancy is heard today without reference to the grading of tumors. This is not a recently discovered method for adding information to what we can discover about any individual tumor, for there is no doubt but that Johannes Mueller, when he first levelled his newly manufactured achromatic microscope at tumors, attempted to correlate the histological pictures with their behavior. But a really new type of grading has been evolved during the last twenty years and the pathologist's knowledge, incidentally often his usefulness too, have been considerably increased since the advent of the X-ray and radium in the treatment of malignancy, for now he attempts to "grade" malignancy according to its sensitivity to these physical agents.

Unfortunately, these two types of grading, *i.e.*, according (1) to prognosis and (2) to X-ray sensitivity, are blended and confused in the minds of many surgeons and röntgenologists and, I might add, pathologists too. The one type of grading attempts to forecast end-results, an entirely different prediction from the second type, which judges whether or not a tumor will be destroyed by the therapeutic use of X-ray or radium.

In more than one communication¹ and in many places, I have stated unequivocally that while the former cannot be done, the latter can be accomplished with a considerable degree of accuracy.

The *a priori* reasons why prognostic tumor grading cannot be done are so obvious that it is strange indeed that so much time is wasted on the endeavor, especially since these reasons have been so abundantly confirmed by the results of various approaches to the problem. If the surgeon completely removes a carcinoma, it will not return. If it is not completely removed, the particles left behind will continue growing. How can a microscopic section reveal how thorough the removal has been? How can a pathologist learn from the removed specimen the location of any tumor tissue that has been left behind? Since the microscopic appearance of most tumors varies in different parts sufficiently to influence the criteria of grading, how many and which specimens shall we take? Besides, various parts of tumors grow at unequal

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rates at one time and at different times. The pathologist is given the opportunity of examining a tumor at only one instant in its life, namely, when it is fixed, and thus cannot tell what its appearance was before it was removed nor can he say what the parts left behind will do. In brief, attempting to prognosticate the course of events from the pathologic examination of a tumor is illogical.

In a general way, the less differentiated the cells, the more sensitive they are to radiation. Thus, highly differentiated adeno-carcinomas are resistant; cornifying squamous-cell carcinomas in many instances are more resistant than the surrounding healthy tissues. Undifferentiated basal-cell carcinomas, on the other hand, are sensitive and are destroyed by radiation. On such broad principles are the guesses made as to whether a given tumor will or will not respond to X-ray therapy.

But always there obtrudes the thought of why certain basic facts about malignant tumors, painfully and laboriously learned over many years, do not determine completely the treatment uninfluenced by variable details and highly controversial opinions. It is known that so few cases of malignancy recover spontaneously that the mortality can be considered 100 per cent. If no treatment is instituted, every patient who develops cancer inevitably dies of it (barring death from automobile accidents, pneumonia, *etc.*). The majority of malignancies begin in an isolated area, even though a few may have multicentric origins. If, therefore, the growth is removed before it has spread beyond the lines of surgical incision, the patient is cured of the tumor. But in early cases, there is no known means of determining how far the growth has extended; unfortunately, in most cases it has spread farther than our fond hopes anticipate.

Therefore, the only decision to be made in any given case is whether or not there is a reasonable hope that the tumor can be completely extirpated. If the decision is that it can, then the most extensive removal should be performed consistent with the presumption that the patient's final state will be no worse than if the tumor had been allowed to remain. If it is decided that the tumor cannot be completely removed, then such remedial measures may be used as seem necessary to insure greater comfort until the inevitable end.

I therefore consistently refuse to grade specimens as to their malignancy, especially biopsy material, mainly because I know various surgeons, on the basis of "grade" of tumor, do a less radical operation than should be done. Do they not realize that even tumors of slowest growth, if given sufficient time, will eventually kill! Do they not realize that carcinoma must not be temporized with!

As far as grading the sensitivity to radiation is concerned, the same principles hold good. If the radiologist treats such a serious disease, why should he not give all that is possible without reference to whether or not the tumor is sensitive! If it is sensitive, he will have success, but if it is an adeno-carcinoma of the body of the uterus or if it is a cornifying squamous-cell carcinoma of the cervix, no curative results will be achieved. The only bar

to radium and X-ray is damage to surrounding healthy tissues, which, unfortunately, occurs often enough.

Therefore, irrespective of details, once the pathologic diagnosis of carcinoma is made, every possible means of extirpation should be used if the judgment is that there is a chance of complete removal, and no detours by grading or other such considerations should be allowed.

In conclusion, may I say that the speaker's impression is that there are many radiologists who agree that in the early case of cancer of the uterus radical surgery offers the best chance of a cure beyond the five-year period. Furthermore, they realize that glandular involvement is beyond the scope of radium but may be reached with the knife. In view of the fact that in about 40 per cent. of cases the regional glands are already cancerous when the patients come for treatment, and that the radiologist cannot tell beforehand whether or not the glands are involved, he may treat cases in which radium is useless and thus deprive them of the benefits of surgery which may effect a cure in about 25 per cent. of cases with glandular involvement. These, I take it, clearly indicate that the time has not yet arrived altogether to discard surgery in the treatment of cancer of the cervix. The sum total of the question lies in moderation. The operable cases should have the advantages of surgery and the inoperable ones the consolation of radium.

REFERENCE

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ASPIRATION OF JOINT EFFUSIONS

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THE importance of aspiration of joint fluids, both of traumatic and inflammatory origin, is not generally recognized. A number of physicians are still guided by the old maxim not to puncture the joint cavity. As a result, the diagnosis is not established and recovery is delayed in many cases. Others aspirate only traumatic effusions of long standing, while the greatest advantage is derived from early evacuation of the hemarthrosis.

This paper is devoted to the practical side of the subject; we shall omit the interesting pathologic and physiologic problems and confine the discussion to the therapeutic and diagnostic value of the aspiration of joints.

THERAPEUTIC CONSIDERATIONS

Joachim Bondessen¹ aspirated traumatic effusions since 1878. In a report published in 1887, he compared the results with the conservative treatment consisting of rest, immobilization, and massage. Of fifty-seven cases treated by aspiration and lavage of the joint with 2 per cent. phenol solution, 86 per cent. made a complete recovery; the average duration of disability was 21.3 days; the maximum 40 days. Of sixty-two cases treated on the conservative lines, only 63 per cent. were completely restored; the average duration of disability was 37.5 days; the maximum 126 days.

In America, Carlton P. Flint² recommended in 1905 to aspirate every traumatic effusion of the knee-joint if a marked decrease of swelling did not occur during the first week after injury.

Ch. Willems,³ following Rochard in France, reported excellent results of early aspiration of traumatic effusions and chronic hydrarthrosis, at the thirty-eighth Congress of the German Surgical Society in the year 1909. He mobilized and permitted walking immediately after aspiration. The average disability of his cases was 9 days. In the discussion, Lauenstein recommended to postpone the aspiration for 24 hours after injury, in order to prevent the danger of re-opening the tear of the capsule and repetition of the bleeding.

Maynard Harding⁴ published, in 1919, satisfactory results of the aspiration in seventy cases of injuries to the knee-joint in Camp Lewis. John J. Moorhead,⁵ in 1921, recommended immediate aspiration and mobilization of traumatic effusions of the knee-joints. Re-aspiration if necessary after 48 hours.

R. F. Metcalfe,⁶ in 1922, reported 300 cases of knee injuries. He aspirated after 48 hours and extended the leg in a special frame. The recovery was complete in 10 days; less than twenty-five cases needed a second aspiration.

In 1925, papers recommending early aspiration of traumatic joint effusions were published from New York Hospital for Joint-Diseases by Walter M. Brickner⁷ and Henry Milch.⁸ Brickner mobilized immediately but did not permit weight bearing for a week. Milch, on the other hand, let his patients walk immediately after aspiration, with good results.

The indication of early aspiration of traumatic effusions is based on the consideration of mechanical and physiologic factors:

The accumulation of fluid expands the capsule and stretches the ligaments of the joint; it interferes with the circulation and irritates the nerve apparatus, which, in turn, causes spasm of the muscles. The blood is absorbed slowly from the joint; it produces inflammatory changes of the synovial membrane. Fibrin is precipitated and organized; it may form a nucleus for the development of loose bodies. The cartilages undergo degeneration. The immobilization of the joints finally can give rise to atrophy of muscles and bone.

The truth of these arguments is established by experimental and clinical evidence. Alfonse Jaffe⁹ has already, in 1897, demonstrated that blood injected into joints of rabbits is only very slowly absorbed, and that it irritates the synovial membrane by precipitation of fibrin. Hueter¹⁰ proved that injured cartilage is overgrown by connective tissue, if the joint be immobilized. Albert Key¹¹ recently amplified and confirmed these experiments.

The clinical evidences of the damage rendered to the joints by hæmarthrosis is very clearly demonstrated by the arthritis which occurs in hæmophilia. Here we have repeated bleeding into the joints, which we do not dare to evacuate. As a result, all joint structures undergo pathologic changes. The synovial membrane is inflamed, hypertrophic, imbibed with iron pigment. The cartilages are eroded, the articular surfaces are hypertrophic, the capsule and ligaments are thickened and fibrotic. The result is a severe, chronic osteo-arthritis.

In papers published recently, Kling^{12, 13} has demonstrated that in severe injuries of the knee-joints the effusion contains fat- and bone-marrow cells besides blood. These elements derived from the fat pads and bone marrow are absorbed with still greater difficulty than blood; they add to the irritation and inflammation of the joints and are a source of loose body formation.

These findings explain the occurrence of chronic osteo-arthritis with loose body formation after severe injuries which were treated without aspiration of the effusion.

The objections against early aspiration of traumatic joint effusions are the possibility of infection and recurrence of the hæmarthrosis. Both are not supported by the experience. Aspiration under ordinary aseptic precautions is harmless. We do not know of one case of infection. Re-aspiration of traumatic effusions is necessary only in a small percentage of cases. The second aspiration shows the effusion to be either serosanguinous or entirely free of blood. The absorption is therefore considerably quicker and the danger of precipitation and irritation is reduced.

Our procedure in traumatic effusions of the joint consists of aspiration 24 hours after injury. The severity and the type of the injury are then determined by examination of the fluid, and clinical method. Cases of simple traumatic synovitis are mobilized immediately and walking is permitted after a few days if the effusion did not re-occur. This management gave us complete recovery within 10 days in over 100 cases of injury with hæmarthrosis, due to tear in the capsule. Injuries to the cartilages and inter-arti-

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cular fractures require suitable conservative or surgical measures, after evacuation of the effusion. By the early aspiration of the effusion in these cases of severe injuries, we reduce the danger of chronic inflammatory changes of the joint after repair of the injury. The evacuation of fat from the joint before reduction and immobilization of intra-articular fractures is also indicated as a preventive measure against fat embolism. This occurrence of fat embolism is emphasized in a recently published monograph on intra-articular fractures of the tibia by Hulten.¹⁴

The Therapeutic Effect of Aspiration of Inflammatory Effusions.—The beneficial action of aspiration of inflammatory joint effusions is not as evident as the evacuation of hæmarthrosis. The cause of the traumatic effusion, the injury, is self-limited. By removing the product we can hope to restore normal conditions. Aspiration of an inflammatory effusion, on the other hand, does not remove the cause of the inflammation. The joint will therefore refill; nothing is gained and the danger of infection is added. These arguments, often repeated, are only half true.

Every effusion has, besides the pathologic aspect, a purely mechanical effect on the joint. Whatever the etiology may be, every effusion causes distension of the capsule and ligaments, muscle spasm, and fixation of the joint. If this process be permitted to continue, unrepairable damage will result, consisting of atrophy of the soft structures, resorption of the bone, inflammation of the synovial membranes or contracture of the muscles.

This chain of damaging effects, which originates in purely mechanical factors, can be broken by early and repeated evacuation of the joint combined with medical, physical and, eventually, surgical therapy. We are just beginning to realize how much havoc the one-sided pathologic viewpoint has played with our management of chronic arthritis. A great deal of the deformation, contractures and suffering was caused by overlooking purely mechanical factors and noninterference with the effusions on strictly pathologic arguments. Yet the same physicians who decline to aspirate joints do not hesitate to puncture the pleura, the peritoneum or the pericardium in inflammatory conditions of these cavities. The danger of infection is certainly not greater in the joints. Carried out under aseptic precautions, the aspiration has proved to be harmless even in purulent and tubercular effusions.

While the mechanical reasons justify the repeated aspiration of inflammatory effusions, a recent study of the viscosity of the fluid seems to indicate that the aspiration has also a beneficial biologic effect. I found that the viscosity of the re-aspirated fluids generally is less than the original preceding effusion. The viscosity, in turn, has a great influence on absorption of an effusion. High viscosity delays, low viscosity favors absorption.

Based on these considerations our procedure is to aspirate inflammatory effusions if, after one week's treatment, a marked decrease of swelling does not take place. Re-aspiration is done in weekly or bi-weekly intervals as long as needed. As a precaution, it is indicated to use a different point of entrance at each re-aspiration.

The immediate effect of the aspiration is a relief of pressure and irritation of the nervous apparatus. Relaxation of muscle spasm takes place and the range of motion is greatly increased. The limb can be brought into correct position and local therapy can be applied with greater efficiency.

Diagnostic Consideration.—Even less recognized than the therapeutic is the diagnostic significance of the aspiration of joint fluids. A number of authors have been quoted in favor of aspiration of traumatic effusions for the curative action, but no reference could be found of an attempt to determine the severity of injuries by examination of the aspirated fluids. The hæmorrhagic character is the only criterion given for traumatic fluids. My studies revealed the presence of fat and bone-marrow elements besides the blood in severe injuries of the knee-joint. On the basis of these findings a differential diagnosis of injuries has been worked out: in slight injuries with tear in the capsule, only blood is found in the effusion; in cases of rupture of the semi-lunar cartilages and intra-articular fractures, fat is torn from the depots in the joints or from the bone marrow and appears in the effusion. Finally, myelocytes and nucleated red cells can be demonstrated in the sediment from the effusion in intra-articular fractures.

This method sometimes gives positive results in avulsions of the articular surfaces of the knee-joint which are not reproduced in X-ray plates; it is also able to clear the diagnosis in cases complicated by a previous injury to the joint or an inflammation.

The differentiation between inflammatory and traumatic effusions is another problem of importance from both a scientific and a practical point of view. Especially in compensation and liability cases do we have to prove the claim of accident by objective methods. The presence of blood in the aspirated effusion is of service only in recent injuries. Its value is further decreased by a possible addition of blood to the fluid from a puncture of a vessel during aspiration. On the other hand, the absence of blood does not disprove the traumatic origin. The blood could have been already absorbed from the synovial cavity at the time of aspiration. In a study¹⁸ I have demonstrated that the bilirubin content is an indication of the origin of the aspirated fluid. Inflammatory fluids have a bilirubin content slightly lower than the blood serum.

Traumatic effusions have a higher quantity of bilirubin than the serum. The increase is accounted for by the breaking down of blood corpuscles and local production of bile pigment from the hæmarthrosis in cases of traumatic synovitis. In fractures also, venous blood from the bone marrow, which is rich in bile pigment, enters the joint cavity. The icteric index is a simple and reliable method for the estimation of the bilirubin content of joint effusions. An icteric index higher than 6 is pathognomonic of traumatic effusion. The icteric index increases with the age of the effusion. The introduction of permanent standards has simplified the bilirubin estimation according to Van den Bergh's method, which has the advantage of being more specific. An indirect Van den Bergh over 0.25 units indicates a local

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formation of bilirubin. It is naturally necessary to exclude the presence of a high blood bilirubin content by estimation of the icterus index or Van den Bergh in the blood serum.

The Diagnostic Value of the Examination of Inflammatory Effusions.—The examination of inflammatory effusions makes it possible to differentiate specific from nonspecific forms of synovitis and arthritis.

Luetic arthritis can be diagnosed more accurately by the outcome of the Wassermann reaction in joint fluids. Reschke,¹⁶ in 1919, reported positive Wassermann reactions in fluid while the blood gave negative results. Poehlman¹⁷ published, in 1923, a comparative study of the Wassermann reaction in the blood serum and in joint effusions and came to the conclusion that the test is, in the majority of cases, identical in both fluids. Some cases gave positive reactions in blood and negative reactions in the synovial fluid. He never met with a positive Wassermann in the synovial fluid while the blood was negative. Since then, Schlesinger¹⁸ and Todd,¹⁹ also Chesney, Kemp and Baetjer,²⁰ in one case, found a positive Wassermann reaction in the joint fluid while the test was negative in the blood serum. Kling²¹ has demonstrated that mistakes are easily made unless the reaction is carried out in the synovial fluid under the uniform and rigid technic. Conducted under these precautions he found the results to be identical in blood and joint fluids in thirty-five cases. Further studies by Kling and Pinkus²² have corroborated these findings in a group of 150 joint fluids.

For the diagnosis of gonorrhœal arthritis, the gonococcus complement fixation test was found in a study of 121 synovial fluids, by Kling and Pinkus,²³ to be specific and to give stronger and more positive reactions than the blood serum. The direct cultures of the gonococcus from the joint fluid is positive only in very recent cases. In a single case I have found gonococci in direct smear from the sediment of the synovial fluid.

In tubercular arthritis the effusion can sometimes contain so many organisms that they will be demonstrated in the sediment of synovial fluids. As a rule we have to resort to the inoculation of the fluid into guinea pigs. It is of advantage to use the sediment in a suspension of saline instead of the full fluid. The results are reliable in a great number of cases. However, some cases of synovitis contain so few organisms that even repeated inoculations fail. Also, in the Poncet type of tubercular arthritis, which is not caused directly by tubercle bacilli, but by toxins produced from a distant tubercular process, the inoculation gives negative results. Another drawback of this method is the length of time (up to eight weeks) necessary to establish a definite result. Hagemann,²⁴ in 1913, published an intradermal test consisting of the injection of 0.1 cubic centimetre of synovial fluid into tubercular guinea pigs which had reacted positively to tuberculin tests. He obtained specific results consisting of local swelling in the centre of which a blue-red discoloration was separated by a white ring from the inflamed periphery. In 4 days a necrosis of the centre developed, later a crust and

finally a scar followed. In a small series of cases we have confirmed these results. However, this work is as yet in a preliminary stage.

The etiology of nonspecific arthritis is far from a definite solution. The finding of different bacteria and of protozoa in blood, faeces and different foci is not conclusive proof of an etiologic relation to a case of arthritis. Only when organisms are cultivated from the joint fluid or membrane are we reasonably sure that the arthritis is a product of their activity. The number of positive findings varies with different authors. In the bacteriology laboratory of the Hospital for Joint Diseases, about 20 per cent. of the fluids examined developed colonies of streptococci, staphylococci or diphtheroids. However, most of the cultures were not positive before one month's incubation. This diminishes the practical value and the reliability of the results.

The study of the cells in the synovial fluid gives some indication of the underlying process. In acute arthritis the number of cells is increased proportionately to the virulence of the infection and polymorphonuclear leucocytes are predominant. In chronic arthritis, monocytes and small lymphocytes increase in number irrespective of the etiology. Forkner, on the basis of his own studies and a review of the literature, came to the conclusion that a count of over 11,000 leucocytes and 60 per cent. polymorphonuclear leucocytes in chronic nonspecific arthritis is likely to be associated with a positive bacterial infection. A cell count under 5000 with under 50 per cent. polymorphonuclears is likely to be negative bacteriologically.

Kling²⁵ has recently called attention to the practical significance of the increase of cells derived from the synovial membrane. A differential count which shows 15 per cent. of synovial cells indicates proliferation of the synovial lining; and an increase of these cells to 25 per cent. is characteristic for a villous synovitis. The differential count of the synovial cells is therefore of value for selection of the cases which require synovectomy or other surgical procedures.

The chemical examination of the synovial fluids has not yet advanced to the point where it could be of practical value for differential diagnosis. A beginning in this direction was made by Nathaniel Allison²⁶ and his co-workers. In four cases of bacterially infected fluids these authors found the sugar content markedly low and only moderately so in two cases of tubercular effusions.

The pH estimation is of some value for prognosis in cases of purulent arthritis. I have found that only severe cases give acid reaction. If the reaction is alkaline, or changes on repeated examination to alkaline, the prognosis is favorable.

Only a few remarks on the technic need be made. The joint to be aspirated is prepared by washing with alcohol and applying iodine. The point of entrance and the underlying deeper tissues to the capsule are anæsthetized with 2 per cent. novocaine. It is very important to employ needles of large gauge because the synovial fluid is of high viscosity and thick and particles suspended in the fluid are apt to clog needles of smaller gauge. With a wide

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needle these particles can be drawn into the syringe and be used for histologic examination.

SUMMARY

The practical value of the aspiration of joint effusions of both traumatic and inflammatory origin is demonstrated. In traumatic synovitis the evacuation of the hæmorrhage is a most effective treatment. In inflammatory conditions the aspiration of large effusions is indicated for the relief of pressure and the distension of the capsule. It restores normal physical conditions and therefore is an effective aid in the treatment.

The examination of the traumatic effusions permits the differentiation of slight injuries from severe injuries and intra-articular fractures by the finding of fat and bone-marrow elements. By the estimation of the icterus index or van den Bergh in the synovial fluid an objective differential diagnosis between inflammatory and traumatic effusions is possible.

Serologic examination (Wassermann and gonococcus fixation tests) on the joint fluids and inoculation into guinea pigs and eventually also intradermal tests with synovial fluid enable the recognition of specific arthritis.

Cultures, cell and differential counts and pH estimations give valuable clues as to the stage, nature and progress of the arthritis in question.

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INTERNAL DERANGEMENTS OF THE KNEE*

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DAMAGE to knee-joints, either by disease or injury, is a condition frequently met with and one which often calls for operative interference for relief or cure. Although the series herein presented is not large, forty-seven arthrotomies on forty-five patients, still the types of derangement are the ones commonly met with.

ABSTRACT OF CASES OF TORN INTERNAL SEMILUNAR CARTILAGES

R. R., aged twenty-one years, female. Period since first symptoms.—Two and one-half years. Length of present attack.—Three days. Symptoms.—Limited flexion, extension and effusion. Primary cause.—Twisted knee while walking. Pathology.—Transverse tear internal semilunar. Sessile tabs on fat pad. Structures removed.—Internal cartilage. Sessile tabs. Present function.—Full. Period until return of full function.—Eight weeks.

E. B., aged sixteen years, female. Period since first symptoms.—Four years. Length of present attack.—Three days. Symptoms.—Limited extension. Primary cause.—Twisted knee in game. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Four weeks.

C. G., aged thirty-two years, female. Period since first symptoms.—Sixteen years. Length of present attack.—Not acute. Symptoms.—Limited extension and effusion. Primary cause.—Twisted knee in misstep. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Seven weeks.

H. K., aged twenty-one years, male. Period since first symptoms.—Three years. Length of present attack.—Eleven days. Symptoms.—Limited flexion, extension and effusion. Primary cause.—Twisted knee in game. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Four weeks.

C. H., aged thirty years, male. Period since first symptoms.—Two weeks. Length present attack.—Two weeks. Limited flexion and extension. Primary cause.—Getting up from knees. Pathology.—Lateral displacement anterior end of cartilage. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Eight weeks.

M. B., aged sixteen years, female. Period since first symptoms.—Three years. Length of present attack.—Not acute. Symptoms.—Locking of knee. Primary cause.—Twisted knee in game. Pathology.—Bucket-handle tear. Adhesions of fat pad to anterior end cartilage. Structures removed.—Internal cartilage. Adherent fat. Present function.—Full. Period until return of full function.—Eight weeks. Previous arthrotomy by another surgeon without removal of cartilage.

R. W., aged forty-two years, male. Period since first symptoms.—One year. Length of present attack.—Not acute. Symptoms.—Locking of knee. Primary cause.—Twisted knee in misstep. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Six weeks.

J. P., aged sixteen years, female. Period since first symptoms.—Fifteen months. Length of present attack.—Not acute. Symptoms.—Giving way of knee. Primary cause.—

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Twisted knee in game. Pathology.—Loose anterior end cartilage. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Four weeks.

W. M., aged ten years, male. Period since first symptoms.—Ten months. Length of present attack.—Not acute. Length of present attack.—Not acute. Symptoms.—Giving way of knee. Primary cause.—Fall from height, injuring knee. Pathology.—Loose anterior end cartilage. Sessile projection from fat pad. Structures removed.—Internal cartilage. Sessile body. Present function.—Full. Period until return of full function.—Five weeks.

L. H., aged thirty-eight years, male. Period since first symptoms.—Three weeks. Length of present attack.—Three weeks. Symptoms.—Limited flexion, extension and effusion. Primary cause.—Getting up from knees. Pathology.—Transverse tear. Hypertrophied fat pad. Structures removed.—Internal cartilage. Fat pad. Present function.—Full. Period until return of full function.—Seven weeks.

A. M., aged fifty-two years, female. Period since first symptoms.—Four weeks. Length of present attack.—Not acute. Symptoms.—Locking of knee and effusion. Primary cause.—Frequent falls from old recurring external dislocation of patella. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Three weeks.

E. B., aged twenty-four years, male. Period since first symptoms.—Three weeks. Length of present attack.—Three weeks. Symptoms.—Limited extension and effusion. Primary cause.—Twisted knee in game. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Four weeks.

M. P., aged twenty-one years, female. Period since first symptoms.—Three years. Length of present attack.—Not acute. Symptoms.—Locking on flexion. Primary cause.—Twisted knee in fall. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Seven weeks.

R. L., aged thirty years, male. Period since first symptoms.—Four days. Length of present attack.—Four days. Symptoms.—Limited extension and effusion. Primary cause.—Twisted knee in misstep. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Eight weeks.

A. C., aged forty-four years, female. Period since first symptoms.—Five years. Length of present attack.—Not acute. Symptoms.—Locking of knee. Primary cause.—Twisted knee in fall down steps. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Four weeks.

B. K., aged fourteen years, male. Period since first symptoms.—Two years. Length of present attack.—Not acute. Symptoms.—Aching and giving way of knee. Primary cause.—Twisted knee in fall. Pathology.—Loose anterior end of cartilage. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Seven weeks.

A. M., aged fifty years, female. Period since first symptoms.—Nine months. Symptoms.—Effusion, limitation of all motion. Held in 20° flexion. Primary cause.—Twisted knee in fall. Pathology.—Bucket-handle tear. Sessile bodies on fat pad. Structures removed.—Internal cartilage. Sessile bodies. Present function.—90 per cent. Flexion limited 20 per cent. Period until return of full function.—Twelve weeks.

E. S., aged thirty-five years, female. Period since first symptoms.—Six weeks. Length of present attack.—Six weeks. Symptoms.—Limited extension and effusion. Primary cause.—Twisted knee in fall. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—75 per cent. Period until return of full function.—Twenty-four weeks.

L. P., aged seventeen years, male. Period since first symptoms.—One year. Length

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of present attack.—Twelve days. Symptoms.—Limited flexion and extension. Snapping on motion. Primary cause.—Twisted knee in jump from height. Pathology.—Bucket-handle tear. Structures cartilage.—Internal cartilage. Present function.—Full. Period until return of full function.—Five weeks.

E. T., aged thirty-two years, male. Period since first symptoms.—Ten years. Length of present attack.—Two weeks. Symptoms.—Recurring locking for five years. Then monarticular arthritis. Then recurring hæmarthrosis periodic locking and limited extension. Primary cause.—Twisted knee at drill in U. S. N. Pathology.—Loose hypertrophied anterior end with villi on post-patellar fat pad. Structures removed.—Internal cartilage. Post-patellar fat pad. Present function.—80 per cent. Recurring hæmarthrosis after four months. Then synovectomy after one year. Listed also under Villous Arthritis when second arthrotomy done on same knee. Period until return, etc.—Five weeks.

L. M., aged twenty-one years, male. Period since first symptoms.—Two years. Length of present attack.—Not acute. Symptoms.—Locking, limited flexion and extension. Primary cause.—Twisted knee in game. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Three weeks.

L. B., aged eighteen years, female. Period since first symptoms.—One year. Length of present attack.—Not acute. Symptoms.—Recurring slipping and locking. Primary cause.—Twisted knee in game. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Four weeks.

F. C., aged forty-three years, female. Period since first symptoms.—Eight years. Length of present attack.—Not acute. Symptoms.—Constant ache, giving way and snapping on motion. Primary cause.—Twisted knee in fall. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Five weeks.

W. R., aged nineteen years, male. Period since first symptoms.—Four years. Length of present attack.—Not acute. Symptoms.—Recurring slipping and giving way. Primary cause.—Twisted knee in game. Pathology.—Double bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Three weeks.

J. S., aged thirty-five years, male. Period since first symptoms.—Five weeks. Length of present attack.—Two days. Symptoms.—limited extension and effusion. Primary cause.—Twisted knee going down embankment. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Five weeks.

R. W., aged twenty years, male. Period since first symptoms.—One year. Length of present attack.—Two weeks. Symptoms.—Limited flexion and extension. Primary cause.—Twisted knee in game. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Three and one-half weeks.

B. A., aged thirty-three years, female. Period since first symptoms.—Four years. Length of present attack.—Not acute. Symptoms.—Aching on use. Primary cause.—Twisted knee in mountain climbing. Pathology.—Posterior end cartilage loose. Sessile tabs from post-patellar fat pad. Structures removed.—Internal cartilage. Post-patellar fat pad. Present function.—Full. Period until return of full function.—Twelve weeks.

W. R., aged forty years, male. Period since first symptoms.—Four months. Length of present attack.—Not acute. Symptoms.—Pain on use. Primary cause.—Twisted knee in fall. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Five weeks.

R. T., aged forty-two years, male. Period since first symptoms.—One week. Length of present attack.—One week. Symptoms.—Limited flexion and extension. Primary

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cause.—Getting up from knee. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Five weeks.

A. G., aged fifteen years, female. Period since first symptoms.—Six months. Length of present attack.—Not acute. Symptoms.—Aching and weakness. Primary cause.—Twisted knee in automobile accident. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Six weeks.

K. D., aged thirty-eight years, female. Period since first symptoms.—Six months. Length of present attack.—Six months. Symptoms.—Limited flexion and extension. Primary cause.—Twisted knee in fall on street. Pathology.—Transverse tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Five weeks.

C. W., aged thirty-eight years, male. Period since first symptoms.—One year. Length of present attack.—Two days. Symptoms.—Limited flexion and extension. Primary cause.—Getting up from knees. Pathology.—Bucket-handle tear. Structures removed.—Internal cartilage. Present function.—Full. Period until return of full function.—Seven weeks.

TORN EXTERNAL SEMILUNAR CARTILAGES

D. S., aged eighteen years, male. Period since first symptoms.—Two months. Length of present attack.—Not acute. Symptoms.—Clicking and snapping of knee. Primary cause.—Twisted knee in fall. Pathology.—Transverse tear. Structures removed.—External cartilage. Present function.—Full. Period until return of full function.—Four weeks.

R. A., aged fourteen years, male. Period since first symptoms.—One week. Length of present attack.—One week. Symptoms.—Limited flexion and extension and effusion. Primary cause.—Fell from pony, twisting knee. Pathology.—Transverse tear. Structures removed.—External cartilage. Present function.—Full. Period until return of full function.—Four weeks.

OSTEOCHONDRITIS DISSECANS

O. S., aged twelve years, male. Period since first symptoms.—Six weeks. Length of present attack.—One day. Symptoms.—Locking, effusion and limited extension. Primary cause.—Twisted knee getting up from kneeling. Pathology.—Loose body. Structures removed.—Loose body, external cartilage. Present function.—Full. Period until return of full function.—Ten weeks. Recurring effusion until then.

W. D., aged nineteen years, male. Period since first symptoms.—Three years. Length of present attack.—Not acute. Symptoms.—Recurring slipping, limited extension. Primary cause.—Came on while walking. Pathology.—Loose bodies. Thickened internal cartilage. Structures removed.—Loose bodies. Internal cartilage. Present function.—Full. Period until return of full function.—Six weeks.

P. W., aged sixteen years, male. Period since first symptoms.—Six weeks. Length of present attack.—Not acute. Symptoms.—Locking and chronic effusion. Primary cause.—Came on while walking. Pathology.—Loose body. Loose anterior end internal cartilage. Structures removed.—Loose body. Internal cartilage. Present function.—Full. Period until return of full function.—Twelve weeks. Recurring effusion until then.

INTRA-ARTICULAR EXOSTOSES

E. R., aged sixty-four years, female. Period since first symptoms.—One year. Length of present attack.—Not acute. Symptoms.—Pain. Locking hæmarthrosis on walking. Primary cause.—Unknown. Pathology.—Intercondylar exostosis femur. Hyalinized fat pad. Hæmarthrosis. Structures removed.—Exostosis. Fat pad. Present function.—Full. Period until return of full function.—Seven weeks.

J. B., aged twelve years, male. Period since first symptoms.—Seven months. Length

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of present attack.—Not acute. Symptoms.—Snapping knee. Limited flexion and extension. Primary cause.—Direct trauma. Caught between two wagons. Pathology.—Exostosis mesial surface external femoral condyle. Structures removed.—Exostosis. Present function.—Full. Period until return of full function.—Twelve weeks.

SESSILE BODIES FROM POST-PATELLAR FAT PADS

J. R., aged twenty-five years, male. Period since first symptoms.—One year. Length of present attack.—Not acute. Symptoms.—Effusion limited extension. Primary cause.—Congenital deformity of feet with frequent falls. Pathology.—Three sessile bodies from fat pad. Structures removed.—Sessile bodies. Present function.—Full. Period until return of full function.—Four weeks.

C. A., aged forty-two years, female. Period since first symptoms.—Three months. Length of present attack.—Not acute. Symptoms.—Giving way of knee. Primary cause.—Fall on to knee. Pathology.—Hypertrophied fat pad. Structures removed.—Fat pad. Present function.—Full. Period until return of full function.—Five weeks.

H. Z., aged twenty-eight years, male. Period since first symptoms.—Eight weeks. Length of present attack.—Not acute. Symptoms.—Pain, effusion, limited extension. Primary cause.—Twisted knee in fall. Pathology.—Hyalinized tabs on fat pad. Structures removed. Tabs. Present function.—Full. Period until return of full function.—Four weeks.

M. B., aged thirty-eight years, female. Period since first symptoms.—Two years. Length of present attack.—Not acute. Symptoms.—Pain. Kink on flexion followed by difficult extension. Primary cause.—Twisted knee in fall. Pathology.—Hyalinized tabs on fat pad. Structures removed.—Tabs. Present function.—Full. Period until return of full function.—Five weeks.

VILLOUS ARTHRITIS

W. C., aged nineteen years, male. Period since first symptoms.—Three years. Length of present attack.—Not acute. Symptoms.—Stiffness. Fusiform swelling knee with mild arthritis other joints. Primary cause.—Infections arthritis. All possible foci removed. Pathology.—Villous arthritis. Structures removed.—Synovial sac and cartilages. Present function.—None. Excision knee after one year.

W. C., aged twenty-one years, male (same patient as above, opposite knee). Period since first symptoms.—Five years. Length of present attack.—Not acute. Symptoms.—Stiffness. Fusiform swelling knee with advancing involvement other joints. Primary cause.—Infectious arthritis. Pathology.—Acute suppurative villous arthritis. Structures removed.—Synovial sac and cartilages. Present function.—Thirty per cent. normal. Period until return of full function.—Eight months.

E. T., aged thirty-three years, male. Period since first symptoms.—Eleven years. Length of present attack.—Not acute. Symptoms.—Recurring hæmarthrosis. Primary cause.—Primary twist with frequently repeated derangement of internal cartilage. Pathology.—Villous arthritis. Structures removed.—Synovial sac and external cartilage. Present function.—Eighty per cent. normal. Period until return of full function.—Two months. (Reoperation after removal internal cartilage one year before.)

M. H., aged sixty-one years, female. Period since first symptoms.—Two years. Length of present attack.—Not acute. Symptoms.—Recurring hæmarthrosis. Primary cause.—Unknown. Pathology.—Villous arthritis exostosis posterior aspect of patella. Structures removed.—Synovial sac, both cartilages and exostoses. Present function.—Full. Period until return of full function.—Six months.

IN ADDITION TO THESE ABOVE CLASSIFICATIONS

Seven cases of torn internal cartilage showed an hypertrophied fat pad which was removed in part or entirely. The cartilage on the affected side was removed with the loose bodies in osteochondritis. Both cartilages were removed in the synovectomy for

villous arthritis. An exostosis on the posterior aspect of the patella was removed in one case of villous arthritis. A hypertrophied post-patellar fat pad was removed in one of the cases of intra-articular exostosis.

Due to weight-bearing and the type of joint, the knee is more apt to become damaged than any other joint in the lower extremity. When the knee is flexed, the inner femoral condyle is rotated or glides on the internal semilunar cartilage on a fixed tibia. When extended, there is no rotatory or lateral motion possible in the knee, due to rigidity of the muscles and to the stretch put on the capsule and ligaments about and within the joint.

Due to this rotatory or gliding motion at the region of the inner cartilage, this structure is the one more apt to give way with seemingly trivial injury. This same twisting motion must be severe to be extended to the outer portion of the knee and for the outer cartilage to become damaged, since the external meniscus, while also attached to the tibia, glides with the femur. Accordingly, there are far more internal than external menisci torn, about ten to one.

The anterior end of each semilunar cartilage is but loosely attached to the capsule of the joint by the coronary ligaments, which are very weak structures. The posterior portion of the cartilage is very firmly attached to the lateral ligament, and so fractures or transverse tears take place at the junction of the two portions due to the difference in mobility of the two ends. Practically never does a cartilage become completely displaced. Instead, we find one or two longitudinal splits in the cartilage, the so-called bucket-handle tear, extending almost the whole length of the structure, or a transverse or oblique tear of the meniscus.

The post- or infrapatellar fat pad, in the sagittal section, is a triangularly shaped structure located below the patella and behind the patellar tendon, covered on its posterior surface by synovial membrane. This structure may have finger-like processes extending backward which cover the anterior end of each cartilage and which are held there by the ligamentum mucosum, which is a thin strand of synovia attached posteriorly just in front of the anterior crucial ligament in the femoral intercondylar notch. These alar pads are often crushed between the femur and tibia on internal rotation of the femur on the fixed tibia, followed by inflammation, swelling and thickening and, with this already damaged and swollen structure extending into this hinge joint, similar trauma is apt to be frequently repeated. Adhesions may form between this pad and the loosely attached front end of the cartilage, dragging it out of place and thus causing repeated locking of the joint. Timbrell Fisher states, "No operation on a semilunar cartilage is complete which does not include the removal of this thickened and inflamed process when present, and conversely it is unnecessary to remove the cartilage when it is clear that the process is solely responsible for the symptoms."

But for the passive part of resistance played by the lateral ligaments in damage to cartilages, they have little else to do with internal derangements of the knee requiring surgery except in knees which, when fully extended, show some lateral mobility where normally there should be none. Here cartilages

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and fat pads both are prone to frequently repeated injuries. This is especially true in adult knock-knees.

While no cases herein reported showed damage to the crucial ligaments, these structures occasionally are torn and lead to severe derangements. In case of torn anterior ligament, free anteroposterior motion of the tibia on the femur is permitted in the flexed position, or hyperextension when the knee is extended: and in case the posterior ligament is torn there is marked backward displacement of the tibia on the femur possible when the knee is fully flexed. These lesions are produced by severe violence.

No other structures within the knee enter into traumatic derangements, except that fractures of the tibial spine can occur, caused by the same type of violence that causes rupture of the crucial ligaments.

The synovial membrane undergoes changes secondary to bony lesions as in hypertrophic or osteoarthritis, or again the result of frequently repeated trauma as in recurring cartilage dislocation, intra-articular exostoses or from monarticular metastatic synovitis. The synovia becomes more villous because of these irritative agents with hyperplasia of all its elements, *e.g.*, newly formed blood-vessels, round-celled infiltration and a gross velvety appearance of the membrane itself. Fatty, cartilaginous or bony changes may take place in these villi, with separation of the involved areas and the formation of loose bodies, or synovial chondromata, which may be so numerous as to fill the synovial sac.

The cartilaginous surface of either patella, tibia or femur, more commonly the latter, may undergo local areas of necrosis with sequestration of the affected area. This is thought to be due to disturbance of circulation, *e.g.*, local thrombosis; early osteoarthritic changes; or to trauma, probably the former. These areas vary in size but are often one to two centimetres in diameter and three-tenths to one centimetre thick. When loose they become smoother than when first separated, increase in size due to addition of cartilaginous cells and frequently become impinged between the femur and tibia, causing locking. These sequestrations are frequently single, and rarely are there more than two or three such loose bodies in osteochondritis dissecans.

Cause of derangement	No. of Cases	Sex M	Age						
			F	10-19	20-29	30-39	40-49	50-59	60-69
Internal semilunar cartilage.....	32	17	15	9	7	9	5	2	
External semilunar cartilage.....	2	2		2					
Osteochondritis dissecans	3	3		3					
Villous arthritis	4	3	1	1	1	1			1
Sessile growths from fat pad.....	4	2	2		2	1	1		
Intra-articular exostoses	2	1	1	1					1
Totals	47	28	19	16	10	11	6	2	2

Of the thirty-four cases herein reported in which the semilunar cartilage was the offender in causing the internal derangement the sexes were almost equally divided, nineteen males and fifteen females. The age period varied

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between ten and fifty-two years. The mechanism in the knee was always a twist, except one case which was incurred in an automobile accident, and probably this was also a twist. Four of these twists occurred in getting up from kneeling.

The symptoms of which the patients complained in the cases in which motion was not limited at the time of operation, fifteen in all, were mainly aching, and pain on use, with recurring slipping and giving way of the knee or locking of the joint. In the remaining nineteen the complaint was limited extension, and limited flexion as well in a few, effusion, pain and loss of full function. In this latter group the shortest period of limited motion before operation was two days and the longest nine months, which patient, incidentally, had had many chiropractic and osteopathic efforts at reduction without avail. In this case at operation all the structures in and about the knee were damaged including the articulating surface of the tibia and femur. Three months after operation she still lacked twenty degrees of full flexion.

The nature of the laceration of the cartilage was found to be almost half the transverse or oblique tear, almost a third of the bucket-handle type and the remainder showed a displaced anterior end, probably produced by the drag of adhesions to this end of the cartilage.

<i>Causes of Torn Cartilages</i>		<i>Types of Torn Cartilages</i>	
Sports	9	Transverse or oblique.....	16
Falls	13	Bucket handle.....	12
Twists while walking.....	7	Loose end.....	6
Getting up from knees.....	4		—
Automobile collision.....	1	Total	34
	—		
Total	34		

Seven cases of damaged cartilage showed hypertrophy of the post-patellar fat pad as well, which was also removed in whole or in part at the time of operation. Only three cases showed any loss of function as an end-result, one which one year later had to have a synovectomy for villous arthritis, and who had had recurring cartilage impingement for ten years with recurring hæmarthrosis, complicated during this period by a monarticular arthritis. Now, a year following synovectomy, he has 80 per cent. function, the loss being in lack of flexion; a second already referred to above; and a third, a tuberculous subject who had, in addition to the torn cartilage, a severe injury to the lateral ligaments of the knee as a result of a fall into a hole in the floor, and whose motion post-operatively was not forced, fearing that a tuberculous synovitis had already set in. This last patient after six months had about 75 per cent. function, this loss being again lack of flexion beyond one hundred ten degrees. Including these three whose convalescence was long, the average time for return of fullest possible function in cartilage tears was six and three-tenths weeks, the usual time being about five weeks, and the shortest three weeks, four patients having discarded all support, had full motion, no limp or feeling of weakness after this short period.

INTERNAL DERANGEMENTS OF KNEE

While it is dangerous to draw conclusions from three or four cases, a few interesting facts present themselves concerning the remaining thirteen cases of internal derangement of the knee.

The three cases of osteochondritis dissecans were all males, aged twelve, sixteen and nineteen, which corresponds to the usual picture; two involved the inner and one the outer femoral condyle, and upon inspection each showed the depressed irregular wrinkled scar from which the loose body was sequestered. Each complained of chronic effusion and recurring slipping and locking. Since some observers maintain that a roughened loose anterior end of the semilunar cartilage shears out this loose body, the meniscus on that side of the knee opened was removed in each case. The convalescence in these cases was slower than the average cartilage patient because of a recurring effusion, due, it is felt, to the chronicity of the effusion before operation. Aspiration repeated two or three times stopped this hydrops with complete restoration of function in all cases in an average time of nine and three-tenths weeks.

The symptoms of the four cases of villous arthritis had existed for long periods, namely, two, three, five and eleven years. In one patient two years after one knee had been operated upon it became necessary to repeat the procedure on the opposite side. One patient had had an internal cartilage and accompanying hypertrophied fat pad removed a year before synovectomy and the third patient had a sharp exostosis, probably the result of hypertrophic osteoarthritis, growing from the posterior aspect of the patella acting as a constant source of irritation to the joint. Two knees showed serous fluid and two blood. Both cartilages were removed as a part of the synovectomy in each case. Only one case showed normal function, as compared to the other knee, as an end-result, that being the one with patellar exostosis, incidentally the oldest patient of the four, aged sixty-one years. The motion of the others was decidedly limited.

In the four cases showing only changes in the fat pad at operation, symptoms had existed in none longer than two years, the shortest being two months. Two had effusion and all complained of periods of limited motion. In none did any locking take place. Three were the result of falls and one a twist, and all regained full function in from four to five weeks after operation and have been free from knee symptoms since. The appearance of these knees at operation was very interesting, in that these finger-like processes extending back from the fat pad often were as long as three centimetres. They were inflamed, velvety-looking and in two cases were definitely hyalinized.

One case of intra-articular exostosis might have been the result of arthritis because the patient was a female, aged sixty-four, who had pain, locking and hæmarthrosis on use of her knee with lipping of the joint edges with an exostosis of the broad flat type which was intercondylar in location and which on full extension of the joint struck the mesial tibial spine. This case also had hyalinized tabs growing from the post-patellar fat pad.

B. FRANKLIN BUZBY

The other case had an intercondylar growth which showed a typical snapping knee, the only patient in the series showing this symptom which is usually caused by a torn external or the detached posterior end of an internal cartilage.

ELAPSED TIME UNTIL ARTHROTOMY DONE

<i>Cause of Derangement</i>	<i>Since First Symptoms</i>			<i>Since Last Attack in Irreducible Cases</i>		
	<i>Shortest</i>	<i>Longest</i>	<i>Average</i>	<i>Shortest</i>	<i>Longest</i>	<i>Average</i>
Internal semi-lunar cartilage	4 days	16 years	28.1 months	2 days	6 months	3.2 weeks
External semi-lunar cartilage	1 week	2 months	5 weeks			15 cases
Osteochondritis dissecans	6 weeks	3 years	13 months	1 day		1 day
Villous arthritis	2 years	11 years	63 months			1 case
Sessile growths from fat pad	2 months	4 years	10.2 months			
Intra-articular exostoses	7 months	12 months	9.5 months			

The differential diagnosis of these derangements necessitating arthrotomy, from the many sprains, contusions, general chronic arthritides and the more acute monarticular infections in which operation is not indicated, is something which tries our skill.

In cartilage cases the tender spot found just above the edge of the tibia, three-quarters of an inch posterior to an imaginary line dropped from the margin of the patella is a very valuable sign, along with the history of locking or giving way. In this series air injection was not used. Although advised by many it is felt the interpretation of X-ray findings is rather difficult. Unfortunately, the X-ray rarely gives any help in cartilage and fat-pad changes, and seldom in osteochondritis.

An observation, not constant but still valuable, is that most often in the locked bucket-handle tear the motion is limited by resilient resistance in both flexion and extension, while in transverse or oblique tears, fat-pad changes and osteochondritis, extension alone is limited. Certainly, recurring locking and effusion with acute localized tenderness in the knee is indication enough for arthrotomy.

KNEES WITH LIMITED MOTION AT TIME OF OPERATION

<i>Cause of derangement</i>	<i>Number of Cases</i>	<i>Number of Joints Limited in Motion</i>	<i>Percentage</i>
Laceration internal semilunar.....	32	18	56.2
Laceration external semilunar.....	2	1	50
Osteochondritis dissecans.....	3	1	33.3
Villous arthritis.....	4	2	50
Sessile growths from fat pad.....	4	3	75
Intra-articular exostoses.....	2	1	50
Totals	47	26	55.3

INTERNAL DERANGEMENTS OF KNEE

In villous arthritis the synovial thickening remaining after complete aspiration, with long lasting disability, plus X-ray changes, makes us try to relieve symptoms by surgery. The X-ray findings in exostoses clinch any suspicions we may have concerning our diagnosis.

While the intra-articular procedure may vary according to the findings, the technic of approach and the post-operative care of arthrotomy of the knee in general might be worth reviewing.

It has been found in my hands that the curved incision of Timbrell Fisher, of England, is most satisfactory. It was used thirty-eight times in this series. Since it is used rather infrequently in this country a word as to its steps might be in place. With the patient's knees flexed over the end of the table and the feet hanging down, an incision is made one inch long through the skin and fat from above downward paralleling the anterior edge of the internal lateral ligament to just above the edge of the tibia and then carried forward paralleling this landmark as far as the patellar tendon.

The fascia of the expansion of the quadriceps is then incised in the same line, exposing the synovia and separated from it at once to facilitate suturing in layers. The synovia is then opened beginning on the horizontal limb at the internal lateral ligament and incising upward and then forward. Exceptional opportunity is given in this incision for inspection of the joint structures, even those in the opposite side of the cavity to that opened. The cartilage, if it be such that is at fault, is cut loose at the front end from the edge of the tibia, and with any attached fat pad is then separated from its attachment to the tibial spine. Then it is grasped by a heavy toothed thyroid forcep and cut away from the internal lateral ligament by a blunt-pointed Noble scissors, curved on the flat, pulling all the time to get the loosened structure between the tibia and femur into the femoral intercondylar notch where the detachment of the posterior end from the tibial spine is easily accomplished. The interior of the joint again is inspected for additional pathology. The foot of the table is then elevated so that the knee is in full extension, when it is sewed up in layers by interrupted sutures of No. 2, chromic catgut subcutaneously, and some nonabsorbable suture in the skin. An alcohol wet dressing and a posterior gypsum splint is then applied.

Many men advise against operating with a tourniquet to obtain a bloodless field, but having done arthrotomies both with and without this aid it is my belief that the dry field is far superior because of the lack of necessity of sponging, which at best is difficult in knee surgery, and which obviates an additional source of infection; and the fact that one can see exactly where and what is being cut, which also is very important.

Many men advise against any drainage in the knee, but due to frequent post-operative effusions, often necessitating aspiration, which put a severe strain on the suture line and perhaps might be a fertile media for bacteria, it has been my custom lately to insert a small piece of rubber tissue in the intercondylar notch, carrying it out near the anterior end of the incision. This has been found adequate in preventing post-operative fluid collection.

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For exploration of the knee-joint and for synovectomy the Jones patella-splitting incision is most valuable. This was used in eight cases. In this, because of the prominence of the lateral femoral condyle, it is important to divide the patella not in its middle but at a point two-fifths of its width from the outer edge, thus permitting easy retraction of both portions over the respective condyles. The longitudinal parapatellar incision was used but once and that in a definite fat-pad injury.

INCISIONS USED

<i>Indication for Arthrotomy</i>	<i>Number of Cases</i>	<i>Timbrell Fisher</i>		
		<i>Semilunar, Internal or External</i>	<i>Jones Split Patella</i>	<i>Longitudinal Parapatellar</i>
Laceration internal semilunar.....	32	30	2	
Laceration external semilunar.....	2	2		
Osteochondritis dissecans.....	3	3		
Villous arthritis.....	4		4	
Sessile growths from fat pad.....	4	2	1	1
Intra-articular exostoses.....	2	1	1	
Totals	47	38	8	1

The rubber-tissue drain is removed forty-eight or seventy-two hours after operation, at the first dressing, and the splint at the end of five to seven days, depending on the amount of swelling, except in those arthrotomies with the Jones split-patella approach. I believe the comfort obtained by the patient from the splint far outweighs any fear of stiffness and delayed return of motion in the joint, the argument advanced by those who do not use post-operative fixation. Passive and guided active motion within the range of comfort is started with the removal of the splint, and within twenty-four to seventy-two hours after this the patient is gotten up on crutches to walk, bearing weight on the affected leg and bending it naturally in walking. This I believe is extremely important for early return of motion. Practically all patients leave the hospital ten days after operation and all within two weeks.

In those knees requiring the Jones split-patella incision, passive and guided active motion is begun at the end of the third week and crutches are permitted at the end of a month. It is interesting to note, however, that even without suturing, on flexion of the knee while the wound is still open, the femoral condyles hold the patellar fragments in very close apposition to each other.

ELAPSED TIME UNTIL RETURN OF FULL FUNCTION

<i>Indication for Arthrotomy</i>	<i>Number of Cases</i>	<i>Shortest</i>	<i>Longest</i>	<i>Average</i>
Laceration internal semilunar.....	32	3 weeks	6 months	6.3 weeks
Laceration external semilunar.....	2	4 weeks	4 weeks	4 weeks
Osteochondritis dissecans.....	3	6 weeks	3 months	9.3 weeks
Villous arthritis.....	4	2 months	8 months	6 months
Sessile growths from fat pad.....	4	4 weeks	5 weeks	4.5 weeks
Intra-articular exostoses.....	2	7 weeks	12 weeks	9.5 weeks

INTERNAL DERANGEMENTS OF KNEE

While there is but one case of villous arthritis in this series that followed an old, neglected, torn cartilage, the seven cases in which the post-patellar fat pad was involved, complicating the loose or torn meniscus, were much longer than the average time of simple cartilage injuries in recovering, *e.g.*, eight and one-tenth weeks; and of these seven cases two resulted in some permanent limitation of function. These cases also averaged thirty-six and three-tenths months before being operated upon, as against an average for the series of twenty-eight and one-tenth months. Thus it might appear that the longer a torn cartilage is permitted to go without being treated operatively, the more apt the patient is to suffer a longer post-operative convalescence and the less apt he is to have a full return of function.

There were no post-operative deaths or deep infections.

As far as can be learned but two patients in this series have had to have a second arthrotomy; one case of cartilage tear which required a synovectomy later, and one case of villous arthritis which necessitated an excision of the knee one year after synovectomy, both of which are reported herein.

No remaining cartilage became torn after a removal of the other. Motion is full, free and painless in all patients counted as having full return of function and in no case is there a complaint of weakness in the knee, many of the younger patients having quickly returned to athletic lives, and all except those with limited function to full active normal lives.

In conclusion, generally speaking, arthrotomy of the knee is a safe procedure if carried out with proper technic, but I must stress the value of operating in a dry field for visibility and absence of sponging; rubber tissue drainage to prevent post-operative effusion; early active motion and use of the part; and lastly, early operation to correct the derangement before other structures of the knee become involved.

THE BEHAVIOR OF ALCOHOL-PRESERVED FASCIA LATA OF THE OX, AUTOGENOUS FASCIA AND CHROMICIZED KANGAROO TENDON IN DOG AND IN MAN

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WITHIN recent years a great deal of attention has been focused on the use of both living and dead fascia for sutures and ligature materials in surgery. This interest was first aroused by McArthur and by Andrews in hernia operations and greatly stimulated by Gallie and LeMesurier in 1924 in their work on hernia repair, using the autogenous fascia lata as sutures. This step seemed



FIG. 1.—Diagram showing posterior gastroenterostomy and lateral anastomosis of the jejunum with occlusion by ligatures at "A" and "B."

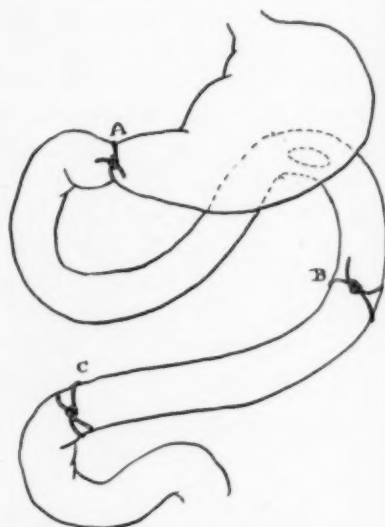


FIG. 2.—Diagram showing posterior gastroenterostomy and site of ligatures. "A" is tied tightly occluding the pylorus; "B" and "C" are loosely tied forming no constriction of the jejunum.

to be a distinct advance over the use of absorbable or non-absorbable sutures in certain fields of surgery.

Years before this, Vulliet first described the use of autogenous living sutures in a nephropexy, using a tendon of the latissimus dorsi. In 1901, L. L. McArthur described a method of inguinal hernia repair by using pedunculated strands of the aponeurosis of the external oblique as suture material. Following this, much experimental work was done on the transplantation of fascia, using it in many ways, but it was years later that fascia was first actually used as suture material.

Gallie and LeMesurier showed that autogenous transplanted fascia strips

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when used for hernia repair neither stretch nor contract, but behave like normal tendons, once the inflammatory reaction has subsided, if the fascia is transplanted to a place where its environment is similar to its original abode. Kirschner, in 1911, found that autogenous tendon transplants placed in the subcutaneous tissue atrophied, while those used to bridge tendon defects remained the original size. He decided that the atrophy was due to non-use.

Many workers have also attempted to cause pyloric occlusion with fascial bands. This subject of pyloric occlusion is a very large one in itself as can be easily understood by the volumes written about it. The works of Strauss, Brewer, Gibson, and Beekmann, in 1914 and 1915, clearly showed what a difficult problem this was and that the pyloric muscle was continually placing a tension on any structure placed about it. Kleinschmidt reported that autogenous fascia placed under the skin and not subjected to strain showed degenerative changes and replacement phenomena more than those which were implanted in muscular defects and subjected to strain.

Lewisohn and Neuhoof noted that autogenous bands of fascia placed about the pylorus to occlude it became incorporated in the pyloric wall and made a very loose ring about the pyloric sphincter, forming no occlusion but a slight constriction. This was also attributed to the foreign surroundings for the fascia and the persistent tension on it.

It has been a disputed question whether fascial grafts remain alive *in toto* or whether their cells are gradually replaced by the surrounding cells. Kornew states that the transplants remain viable as such, but Neuhoof believes that "the permanent viability cannot be accepted as established when widespread replacement phenomena and evidences of degeneration exist. Mimicry of the appearance of any original graft by the replacing tissue is a frequent occurrence."

On account of the objection to performing an additional operation in order to obtain autogenous fascia for the suture material and following the idea of Nageotte, who, in 1917, transplanted pieces of alcohol-preserved tendon to repair anatomic defects in the tendons of living animals, Koontz, in 1926, suggested using alcohol-preserved strips of fascia lata of the ox in place of the living sutures. He first used this in experimental hernia repair and on account of the favorable results extended it to the repair of defects of the hollow viscera and other structures. He claims that this replacement process of

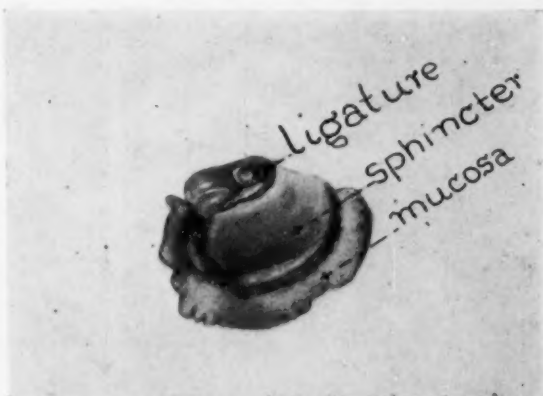


FIG. 3.—Experiment No. 1. Trans-section of wall of pylorus showing kangaroo-tendon ligature 192 days after operation. Note that the ligature is intact, and has become imbedded in peritoneum.

autogenous living fascia occurs in the same manner in dead fascia preserved in 70 per cent. alcohol as in the living. "The dead cells of the graft have been replaced by cells from the host, the graft becomes finally fixed to the surrounding tissue by ingrowths of fibroblast, and the implant becomes vascularized." He assumes that the dead and living fascia undergo similar changes.

Hutchinson has reported the presence of kangaroo tendon two years after implantation of hernia repair and that the microscopic sections showed them to be normal fibrous tissue, part of the living structure of their host. However, the type of preservative was not stated and this has not been the general finding in chromicized kangaroo tendon where absorption occurs.

Following this work I have attempted to compare the reaction in the peritoneal cavity and in the abdominal wall of the dog, of the autogenous fascial transplants with that of the alcohol-preserved fascia lata of the ox which



FIG. 4.

FIG. 4.—Experiment No. 9. Dead fascia ligature on the intestine of a dog, five weeks after operation. Note that there is no tendency toward encapsulation. The fascia has blended with the intestinal coat and is covered externally by peritoneum. Along the edges of the fascia vascularization has taken place. (x75.)

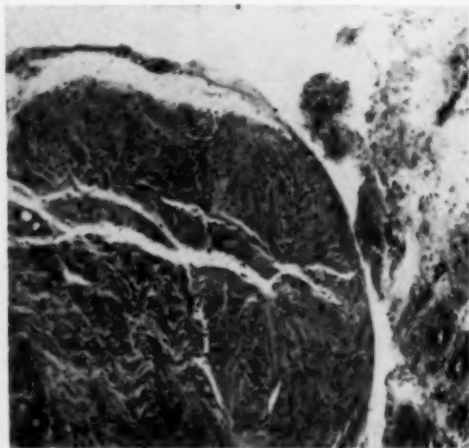


FIG. 5.

FIG. 5.—Experiment No. 9. Higher power of preceding figure, showing the peritonization of the fascia. (x150.)

Koontz used. With these two suture materials I have used for comparison chromicized kangaroo tendon. These three materials were tied loosely about the small bowel in the peritoneal cavity, snugly about the pylorus, and also placed in the abdominal wall. This would give a comparison of the reaction in the normal habitat of the fascia, when next to muscle and tendon, and in the peritoneal cavity, an entirely foreign surrounding. By attempting to occlude the pylorus, the material used would be put under tension by peristalsis and thus the amount of relaxation these structures would undergo in the peritoneal cavity could be determined.

Experimental Work.—All of the experimental work was performed on dogs, sixteen experiments in all being done. The experiments extended over periods varying from five days to a little over six months (192 days). Eleven were intra-abdominal and the remaining five in the abdominal wall. The living autogenous fascia was all obtained

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from the rectus sheath of the dog, the dead fascia was the alcohol-preserved fascia lata of the ox prepared commercially according to the method of Koontz, and the kangaroo tendons were all medium chromicized strands.

Intra-abdominal Technic.—A—Through an upper right rectus incision the stomach, duodenum and jejunum were exposed. Three ligatures were loosely tied about the pylorus one-half inch apart in the following order: (1) Medium kangaroo tendon. (2) Alcohol-preserved fascia lata of ox. (3) Strip of rectus sheath. The kangaroo tendon was always tied three times and the other two were tied twice with the loose ends stitched together with thirty-day chromic catgut. This procedure was repeated about eight inches below the pylorus, on the jejunum. None of these ligatures were placed tight enough to constrict the lumen of the gut.

B—The same type of incision was used as above. A ligature of one of the materials was placed about the pylorus one-half inch above the sphincter and tied tightly, completely occluding the pylorus. A posterior short loop gastrojejunostomy was then performed (Fig. 1, A). A foot or more below this a lateral anastomosis of the jejunum was done and the loop of bowel was occluded with one of the other ligature materials (Fig. 1, B). In some instances the lateral anastomosis was not done, but the two materials that were not used to tie about the pylorus were tied loosely around the jejunum about six inches apart (Fig. 2, B and C).

The following tables give findings when the dogs were autopsied:

LIVING AUTOGENOUS FASCIA IN ABDOMINAL CAVITY

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
1	6 months and 1 week	There were many adhesions about both sites, the ligature having been placed about the pylorus and the duodenum. The ligatures blended into the surrounding structures and could not be definitely identified. They stretched similar to the surrounding tissue. Microscopically, they could not be identified.
4	6 weeks	There were many adhesions where the ligature was tied about the pylorus, but none about the jejunum. Microscopically, it could hardly be distinguished from the other tissue, but showed a good deal of replacement especially about the jejunum. It would give to tension.
9	5 weeks	There were a few adhesions present. The pylorus was completely occluded, and did not leak under hydrostatic pressure. The ligature did not stretch. It was placed only about the pylorus.
8	3 weeks and 2 days	There were a few adhesions about the pylorus, where the ligature had been placed. The pylorus was completely occluded, and the strip of fascia did not stretch. There did not appear to be much replacement.
10	17 days	There were many adhesions, and there was some blending of the ligature.
7	5 days	There were a few adhesions about the pylorus and jejunum, but otherwise no changes were noted.
3	The dog died at the end of 5 days from peritonitis, due to a leak in the suture line of the gastroenterostomy. None of the rectus sheath could be found.	
11	The dog died of intestinal obstruction on the fifth post-operative day because of the ligature being tied too tightly about the gut. The ligature appeared normal.	

GUY W. HORSLEY

ALCOHOL-PRESERVED FASCIA LATA OF THE OX IN ABDOMINAL CAVITY

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
1	6 months and 1 week	The ligatures which had been placed about both the pylorus and jejunum could not be definitely identified grossly, nor microscopically. The area where they had been placed stretched normally with the rest of the gut. There were many adhesions about these places.
2	6 months	This one had been placed about the jejunum only, occluding the gut and a lateral anastomosis done. There was no trace of this ligature found grossly nor microscopically; the lumen of the gut was wide open.
4	6 weeks	The ligatures had been placed about both the pylorus and jejunum and appeared to be greatly diminished in size. Many adhesions were present, and they stretched under tension. Microscopically, much replacement was noted.
6	5 weeks	The ligature was placed only about the pylorus. Many adhesions were present. The strand was diminished in size and stretched a very little. Occlusion of the pylorus was attempted at the beginning of the experiment, but it leaked water under pressure; the pylorus still seemed to be slightly constricted.
9	5 weeks	The ligature was placed about the jejunum. A few adhesions were present, and there had been considerable reorganization with the formation of blood-vessels in its outer portion. This ligature would stretch under tension (Figs. 4 and 5).
8	3 weeks and 2 days	The ligature was placed only about the jejunum. Very few adhesions were noted. There was very little diminution in the size of the ligature, and it did not stretch. Some reorganization was seen microscopically.
10	17 days	There were many adhesions, otherwise the ligature appeared quite normal.
7	5 days	There appeared to be no changes in the ligature. There were a few adhesions present.
3	The dog died at the end of five days from peritonitis, due to a leak in the suture line of the gastorenterostomy. None of this dead fascia could be found.	
11	The dog died of intestinal obstruction on the fifth post-operative day. The ligature appeared normal.	

KANGAROO TENDON IN THE ABDOMINAL CAVITY

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
1	6 months and 1 week	The ligature had been placed about both the pylorus and the jejunum. There were only a very few adhesions, and apparently only slight absorption of the ligature; it did not stretch under tension (Fig. 3). Microscopically, there was definite encapsulation and some absorption could be noted at the edges. More absorption of the ligature about the jejunum was noted.
2	6 months	The ligature had been tied tightly about the pylorus. A few adhesions were present and the ligature did not appear diminished in size. The pylorus was completely occluded even under great hydrostatic pressure. The ligature had cut into the pyloric muscle a little, and microscopically there was encapsulation of the strand but very little absorption noted.

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5	7 weeks	The ligature had been placed about the pylorus. No adhesions were noted. The pylorus was completely occluded even to hydrostatic pressure. Apparently no absorption had taken place, and there was no stretching of the ligature.
4	6 weeks	No adhesions were noted about the ligature at either the pylorus or the jejunum. There was more absorption of the ligature placed about the jejunum than of the one about the pylorus. Microscopically, there was encapsulation but very little degeneration (Figs. 6 and 7). There was no stretching of the ligature.
6	5 weeks	The ligature had been placed only about the jejunum, occluding the lumen, and a lateral anastomosis had been done. There were no adhesions; the ligature seemed to be somewhat smaller than originally and stretched a little on tension. The gut lumen was not occluded. Microscopically, there was a fair amount of absorption, the ligature being encapsulated.
9	5 weeks	The ligature was placed loosely about the jejunum. There were no adhesions noted, and it did not stretch. There was apparently some diminution in size.
8	3 weeks and 2 days	The ligature had been placed loosely about the jejunum only and when examined was about half the original size. No adhesions were present. The ligature did not stretch on tension and was encapsulated.
10	17 days	The ligature was only placed loosely about the jejunum. A few adhesions were present, and it was encapsulated. There was no change in size nor was any absorption noted.
7	5 days	There were no changes noted in the ligature. The pylorus was completely occluded.

Technic for Abdominal-wall Experiments.—A small incision was made in the lower right abdomen just over the right rectus muscle. The sheath of the rectus was bared for about three inches. Two small, longitudinal nicks were made with a knife in the rectus sheath and a blunt forceps passed between them so that a small bundle of muscle fibres and rectus sheath were gathered up. About this was placed a piece of kangaroo tendon which was loosely tied (Fig. 8, 1). This same procedure was repeated, using a piece of the rectus sheath (Fig. 8, 2) from another incision and also a piece of alcohol-preserved fascia lata of the ox for the third (Fig. 8, 3). These last two ligatures were tied twice and the ends caught together with No. 00 thirty-day chromic catgut. The skin incision was then closed with linen.

The following table gives the results noted at autopsy of the dogs:

LIVING AUTOGENOUS FASCIA IN ABDOMINAL WALL

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
12	6 weeks	There appeared to be no line of demarcation between the ligature and the surrounding tissue. It appeared healthy, but did not stretch. Microscopically, there seemed to be some replacement and vascularization (Fig. 9).
13	5 weeks	The findings were the same as those in No. 12.
14	3 weeks and 2 days	There was infection in the incision and none of the material could be found.
15	2 weeks and 3 days	There was some infection in the incision and none of the material could be found.

- | | | |
|----|--------|---|
| 16 | 1 week | There was some blending of the ligature into the surrounding tissue but still a line of demarcation could be made out. Microscopically, there appeared to be little or no change from the original. |
|----|--------|---|

ALCOHOL-PRESERVED FASCIA LATA OF OX IN ABDOMINAL WALL

There could be noted no difference between the behavior of this material and that of the living fascia, so the above may be taken for these observations, too.

KANGAROO TENDON IN THE ABDOMINAL WALL

<i>Experiment</i>	<i>Age</i>	<i>Remarks</i>
12	6 weeks	The ligature appeared smaller and did not stretch. Microscopically, it was encapsulated and showed absorption about the edges (Fig. 10).
13	5 weeks	Observations here exactly coincided with the above.

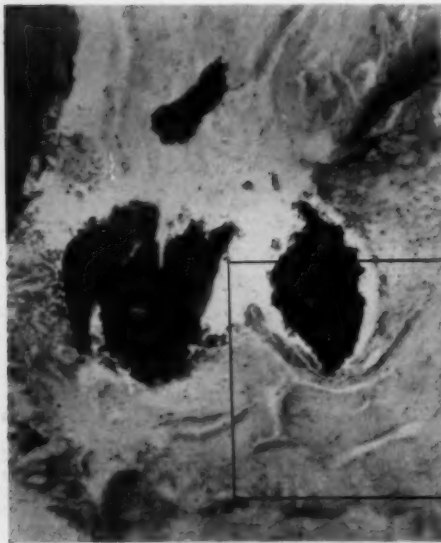


FIG. 6.



FIG. 7.

FIG. 6.—Experiment No. 4. Kangaroo-tendon ligature on pylorus six weeks after operation. The ligature has become deeply imbedded in the muscular coat. It is definitely encapsulated. Due to its resistance part of the kangaroo-tendon was displaced in cutting the sections. (x110.)

FIG. 7.—Experiment No. 4. Higher power of preceding figure showing the encapsulation and slight absorption at the edges.

- | | | |
|----|-----------------------|--|
| 14 | 3 weeks and
2 days | There had been a good deal of infection in the incision and none of the material could be found. |
| 15 | 2 weeks and
3 days | There had been some infection in the incision, but some of the material was left, though diminished. There was no stretching of what remained. |
| 16 | 1 week | The ligature appeared the same as when placed in the abdominal wall. There was some encapsulation microscopically, but apparently no absorption. |

Gross examination of the specimens showed that there was very little absorption of the kangaroo tendon and in no instance was there any stretching. There was apparently no noticeable difference between the dead alcohol-preserved fascia of the ox and the living autogenous fascia; about both there was a moderate amount of adhesions, more than about the kangaroo tendon. The alcohol-preserved fascia of the ox would

FASCIA LATA GRAFTS

stretch more than the living autogenous fascia. In the older experiments, it was often almost impossible to find where the living autogenous fascia and the dead alcohol-preserved fascia had been placed, except for the presence of adhesions. Those placed about the pylorus had more adhesions than those about the jejunum, but less of the original material was found about the latter. This was very noticeable in all of the materials.

Microscopic examination of the materials showed them covered with peritoneum,



FIG. 8.—Experiment No. 12. Ligatures imbedded in the muscle and fascia of the abdominal wall. (1) Kangaroo tendon; (2) Living autogenous; (3) dead fascia.

which, Hertzler has pointed out, occurs with great rapidity when foreign bodies are placed in the peritoneal cavity (Fig. 5). There was a tendency to encapsulate the kangaroo tendon with only slight absorption noted in the edges in the older experiments (Fig. 7). The living autogenous fascia and the dead alcohol-preserved fascia behaved quite similarly, there being somewhat more actual evidence of degeneration and replacement in the latter. In those that were six weeks old and older vascularization of the edges of the materials was readily noted. The kangaroo tendon had cut down into

the muscular layers when it had been placed about the pylorus under tension (Fig. 6). Microscopically, it was also noted that there was more apparent absorption of the kangaroo tendon and replacement of the other two materials when placed about the jejunum than about the pylorus. The fact that some were tied under tension did not seem to have any factor in this observation.

Where there was peritonitis no trace could be found of the living or dead fascia, but the kangaroo tendon appeared normal though somewhat diminished in size. The jejunum was occluded in several instances with each kind of material, a lateral anastomosis being done, but there was no occlusion of the jejunum noted at the time of autopsy, although it was slightly constricted when the kangaroo tendon was used.

There was a more rapid encapsulation and absorption of the kangaroo tendon placed in the abdominal wall (Fig. 10) than about the pylorus or the jejunum. The reverse was true of the living and dead fascia. In the abdominal wall the fascial transplants seemed to fade into the surrounding tissue more quickly, but held their original size

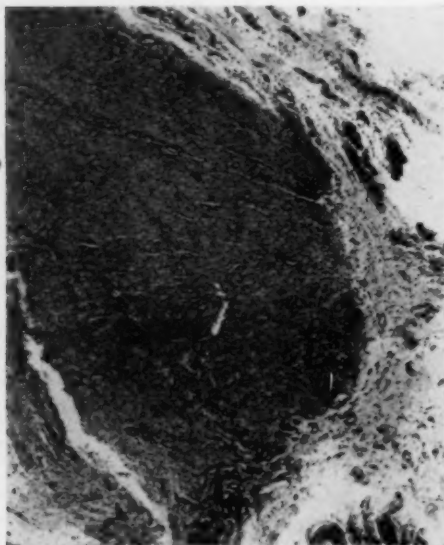


FIG. 9.

FIG. 9.—Experiment No. 12 (2). Living autogenous fascia ligature imbedded in abdominal wall and removed six weeks after operation. There is no encapsulation or absorption. The fascia has become vascularized along the margins. (x75.)



FIG. 10.

FIG. 10.—Experiment No. 12 (1). Kangaroo-tendon imbedded in abdominal wall showing definite encapsulation with absorption about the edges. Specimen six weeks after operation. (x85.)

and strength much longer, which is probably due to the fact that they were more in their normal habitat, fascia and muscle, than when in contact with the peritoneum. This also coincides with the observations of others who have attempted to occlude the pylorus with fascial bands and found that the fascia will soon stretch and the pylorus will again become patent.

When there was infection in the incision, both types of fascia soon broke down and were quickly absorbed, while the kangaroo tendon was only slightly absorbed. In no instance was there encapsulation of the fascia, as occurred wherever the chromicized kangaroo tendon was used and no inflammatory reaction was noted about the kangaroo tendon.

The observations on alcohol-preserved fascia lata of the ox as recorded above largely coincide with those of Koontz, but from clinical experience the reactions of this alcohol-preserved fascia lata of the ox in man have been con-

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trary to what would be expected from these experiments in dogs. I have observed the following five cases which were operated upon by Dr. J. Shelton Horsley and which will illustrate this point:

CASE I.—White man, aged forty-eight years. A pyloroplasty was done through an upper right rectus incision. The incision was closed in layers, the peritoneum and posterior rectus sheath with No. 1 chromic catgut, the anterior sheath of the rectus muscle with a continuous suture of alcohol-preserved fascia lata of the ox. The subcutaneous tissue and skin were sutured with catgut. The fascia was transfixed on itself according to the method of Gallie. Nine days after operation the incision broke open, there having been very little post-operative distension or abdominal straining. At this time a careful examination was made and only a few small strands of the ox fascia could be found, and this was readily torn when pulled upon. It appeared to have undergone much digestion and disintegration. There was no infection of the incision. He weighed 163 pounds.

CASE II.—White man, aged thirty-six years. The same type of incision was made as in Case I, the operation being a gastroenterostomy. The wound was closed in layers, the peritoneum and posterior rectus sheath with a continuous stitch of No. 1 chromic catgut, the anterior sheath of the rectus with a continuous overhand stitch of alcohol-preserved fascia lata of the ox, and the subcutaneous tissue and skin with catgut. After operation there was a good deal of abdominal distension from gas. On the sixth post-operative day the wound was found gaping. There was no trace of infection and only small friable strands of the ox fascia could be found, there having been much absorption. This patient weighed 127 pounds.

CASE III.—White man, aged forty-two years. A large post-operative ventral hernia was repaired by using autogenous strips of the fascia lata after the method of Gallie. These strips were used as continuous sutures, passed through the posterior sheath of the rectus muscle, and then another layer placed in the same manner, bringing the anterior sheath of the rectus muscle together, the peritoneum having first been closed with No. 1 chromic catgut. The subcutaneous fat was sutured together with plain catgut and the skin with fine silkworm-gut sutures. The ends of the fascia were transfixed with fine kangaroo tendon, and two strands of the kangaroo tendon were used to reinforce the fascia in the central part of the incision. A firm scar was formed which has continued to hold perfectly. He was operated upon in September, 1930. He weighed 246 pounds.

CASE IV.—White man, aged fifty-three years. A large strangulated post-operative hernia was repaired in April, 1930. The peritoneum and posterior sheath of the rectus were closed with two strips of autogenous fascia lata and the anterior sheath with one strip. Fine black silk was used to transfix the ends of the fascia. There has been no recurrence of the hernia. The patient's weight was 196 pounds.

CASE V.—White woman, aged fifty-six years. On February 3, 1930, a cholecystectomy was done through an upper right rectus incision. The wound was closed in layers, the peritoneum and the posterior sheath of the rectus being sutured with two strips of alcohol-preserved fascia lata of the ox, and the anterior sheath of the rectus muscle with one strip. The ends of the fascia were transfixed with black silk. A firm abdominal binder was placed on the patient and kept on for three weeks to relieve any tension that may have been placed on the incision. The patient was quite fat and there was a slight infection in the fat at one point of the wound. Six months later the patient returned with a large ventral hernia which was repaired by using autogenous fascia lata. The same method of closure was used this time as before. The ends of this fascia were transfixed with fine kangaroo tendon and two strands of the kangaroo tendon used to reinforce the central part of the incision. There has been no recurrence of the hernia which was repaired about ten months ago.

Comment.—From these cases it is obvious that the alcohol-preserved fascia lata of the ox as obtained on the market does not behave in man like the autogenous fascia lata, but is readily digested and broken down, while the autogenous fascia holds exceptionally well.

The reasons for the discrepancy between the experimental and clinical work can only be surmised. The fact that man is further removed from the ox in the biological scale of life than is the dog may be one of the factors here. The tissues of man are more highly organized than are the tissues of the dog; so, while experiments concerning mechanical technic which work out satisfactorily on dogs will probably also succeed in man, but experiments that depend upon the biologic reaction to foreign transplanted tissues may not give the same results in man as in the dog. The fact that man is often sensitized to foreign proteins and may react violently to them when placed in his tissues probably accounts for many of the differences noted in the experiments of tissue transplantation in animals and in man.

CONCLUSIONS

1. Dead alcohol-preserved fascia of an ox and living autogenous fascia react similarly in the peritoneal cavity and in the abdominal wall of the dog. In no instance does encapsulation occur.

2. Kangaroo tendon soon becomes encapsulated, and is absorbed more quickly in the abdominal wall than in the peritoneal cavity.

3. The fascias, both dead alcohol-preserved of the ox and the autogenous, atrophy and stretch when placed in the peritoneal cavity, but not in the abdominal wall.

4. For pyloric occlusion chromicized kangaroo tendon is much more satisfactory, forming total occlusion for over six months in the dog and causing fewer adhesions than the fascia. The living fascia seems to occlude the pylorus several weeks longer than the dead alcohol-preserved fascia of the ox.

5. If infection is present, both the living and the dead alcohol-preserved fascia of the ox is broken down and absorbed, while chromicized kangaroo tendon shows a high degree of resistance to infections.

6. The alcohol-preserved fascia of the ox does not react in man as it does in the dog, but is quickly absorbed and loses its tensile qualities, while the autogenous fascia lata in man apparently retains its strength.

7. The reasons for this difference in behavior between the dead alcohol-preserved fascia of the ox in the dog and in man is not definitely determined. It may be due to the fact that man is higher in the biological scale than the dog or ox, his tissues are more complex and consequently the proteins of the fascia lata of the ox are more foreign to his tissues than to the tissues of the dog. One of man's chief articles of food is beef, and this fact, also, may increase the rapidity with which foreign beef proteins are absorbed in man, once they have been introduced into his tissues.

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IMPROVED ARMAMENTARIUM FOR FRACTURE REDUCTION AND RETENTION

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BECAUSE it is felt that a definite step forward has recently been made in the care of certain fractures, the essayist wishes to outline certain practical points concerned with these fractures as seen at the Kansas City General and Research Hospitals. The essayist wishes at this time to acknowledge the help of Dr. R. M. Schauffler in awarding cases for the study and application of these newer methods. Ideas of Dr. M. W. Pickard, and others engaged in traumatic surgery in the Research Hospital have been freely used, and are gratefully acknowledged. The methods chiefly considered are those of Böhler, of Vienna, as employed by Dr. S. R. Cunningham, of Oklahoma City. The latter has applied most aptly, to the American patient, the principles which Böhler applies to the Austrian. It is well to note here that there are certain of Böhler's methods which would unquestionably not be tolerated by the average American citizen. Therefore, what is discussed here is technic which has been repeatedly used on Americans and found to be well tolerated by them.

The problems involved in fractures of the long bones are chiefly as follows: (1) Sufficient traction to overcome shortening. (2) Difficulty of applying traction in certain locations (fractures of lower leg, hip, etc.). (3) Lack of appliances affording good retention and at the same time capable of minor adjustments to correct position from time to time. (4) Lack of an alternative to cumbersome plaster cases, general anæsthesia and recumbency in certain fractures in the aged. (5) Lack of a good method, without the use of foreign material, in compound fractures following débridement, or during Dakinization. (6) Difficulty in restoration of function where extremity had of necessity to remain in plaster. (7) Avoidance of secondary operations to correct deformity, remove metal plates, etc. (8) An appliance or method for immediate use requiring no subsequent change until union takes place.

To illustrate the difficulties encountered in fractures of the leg, I went to the 1929 records at the Kansas City General Hospital. From these I chose at random cases of that year in which the fragments were displaced on admission. Fig. 1 illustrates four cases, the first four encountered which filled the requirement of *displaced fragments when admitted*. It must be stated that these were not all primarily treated in the General Hospital, and after admission were not all cared for by the chiefs of the fracture services. They do, however, represent the average results, I dare say, of the average busy, charity, fracture service in 1929.

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Fig. 1.—Types of fractures of the leg and deformities so difficult of correction prior to use of Böhler procedures.

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CASE I.—J. G. (36299). Showing *posterior bowing of leg* as of February, 1929. The first röntgenograms made at the hospital were dated February 21, 1927. Ones made again in March, 1927, showed a Parham band in place, the bone ends apposed, but posterior bowing, foot drop and bone atrophy. The end-result here shown speaks for itself.

CASE II.—M. C. (44696). Showing *fracture of the lower third of the tibia* with typical posterior displacement of the lower fragment as of August 6, 1929. Note foot drop. The same condition obtained at the time of admission, July 31, 1929, and before application of the plaster case.

CASE III.—M. C. (44530). Showing another *fracture of the lower third of the leg* the day after application of a plaster case (July 16, 1929). Note the medial displacement of the lower fragment. A Lane plate was applied in August, and röntgenograms as late as October, 1929, show no appreciable callus formation, although good alignment was secured at operation.

CASE IV.—D. R. B. (44454). Showing *fractures of the upper ends of the tibia and fibula*. Note the direction of the line of weight bearing of the upper fragment in relation with the lower fragment as of August 15, 1929. The first pictures were made July 8, 1929. The next films bear the date of July 10, 1929, and showed the leg in plaster, no attempt having been made, or an unsuccessful attempt having been made to reduce the deformity. (The röntgenogram is of the leg in plaster six weeks after admission.)

Since the introduction of the Böhler splint into the fracture service at the Kansas City General Hospital nine months ago (service of Doctors Dickson and Dively), a score of fractures has been treated on this type of frame. A number were made, and during the past fall and winter practically all compound fractures of leg or thigh were treated on them. The results were highly satisfactory, in our opinion. I will illustrate the virtues of the appliance incidental to the case histories given in brief. Fig. 2 illustrates four cases as nearly analogous to those shown in Fig. 1 as it was possible to find.

CASE Ia.—C. (48968). *Compound fracture of both bones of the leg in the lower third*, with massive hæmatoma of the leg and destruction of skin. This lad was placed at once (November 16, 1930) on a Böhler splint. Prior to application of skeletal traction position was temporarily maintained with skate cleat on sole of shoe attached to weight cord. The débridement was done early without removing the leg from traction. Dakinization was used and on several occasions minor adjustments were made, and loose fragments were removed. Note that position was maintained until callus formation was sufficient and wound secretion minimal, when a plaster case was applied (January 14, 1931) and the patient allowed up and about in a wheel chair.

CASE IIb.—L. (50305). *Compound fractures of both bones of leg* with considerable comminution. There was a coincident skull fracture, and fracture of the right humerus. The lad was in coma and delirium for about two weeks. The leg was placed at once in a Böhler frame, and débridement done (January 5, 1931) under local anæsthetic. A Steinmann pin was inserted at the same time, and the wound Dakinized from then until suppuration had practically ceased. Note that the alignment was maintained, and fragments which appeared at first to be of questionable vitality have become incorporated in the callus. In this case, as in all of this series, no trouble was had with drop foot or pain, and no foreign material other than Dakin's tube or drain was used. (Admitted January 2, 1931. Case applied February 14, 1931.)

CASE IIIc.—F. J. (50001). *Compound fracture of the lower leg*. Steinmann pin and Böhler frame used early and wound Dakinized. The film shows safety pins holding sling under entire length of the leg. This is a mistake, and since the advice of Dr. M. W. Pickard has been followed, and the calf of the leg has been permitted to sag, we have

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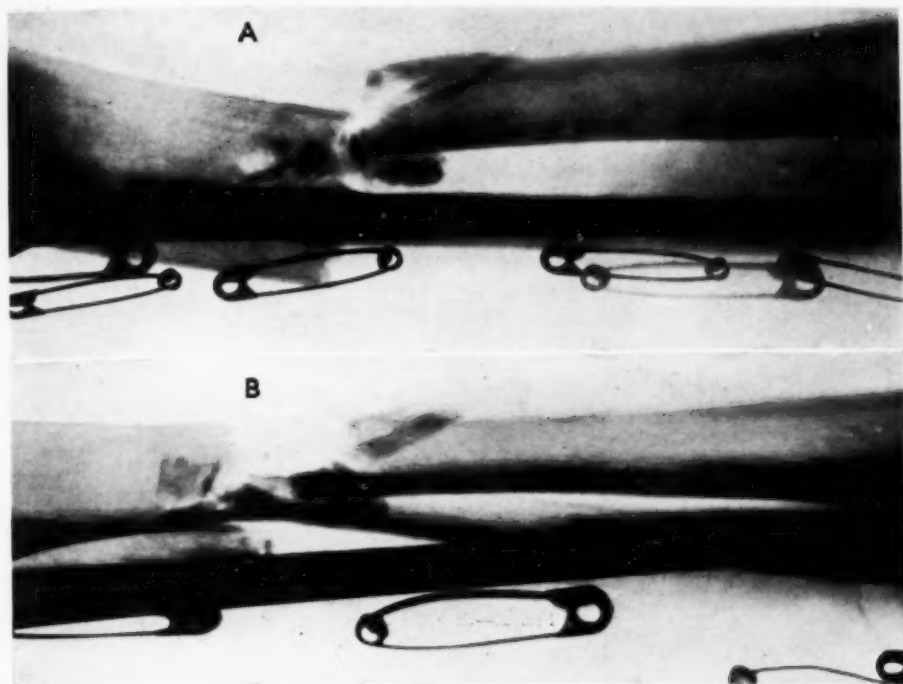


FIG. 2.—Case Ia.

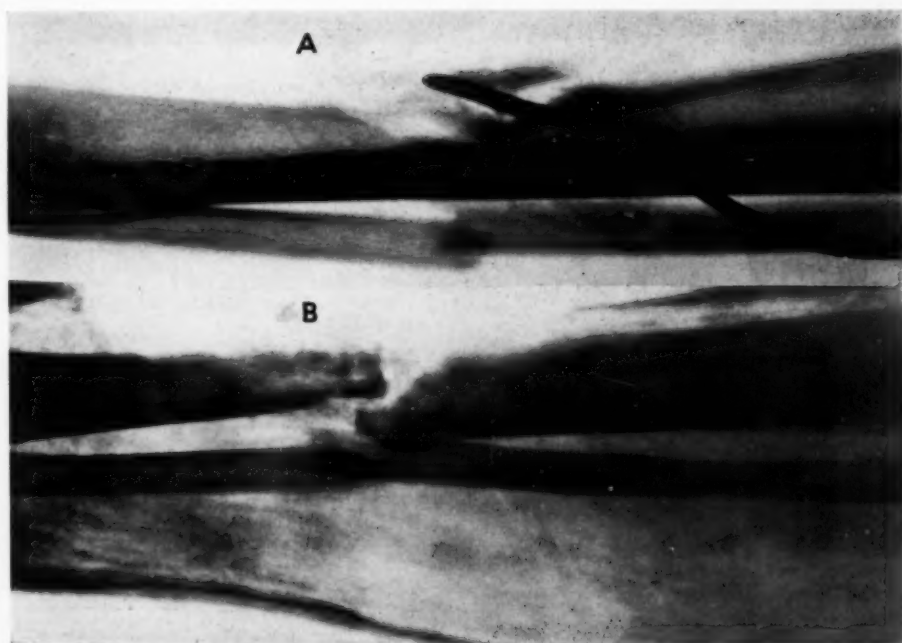


FIG. 2.—Case IIb.

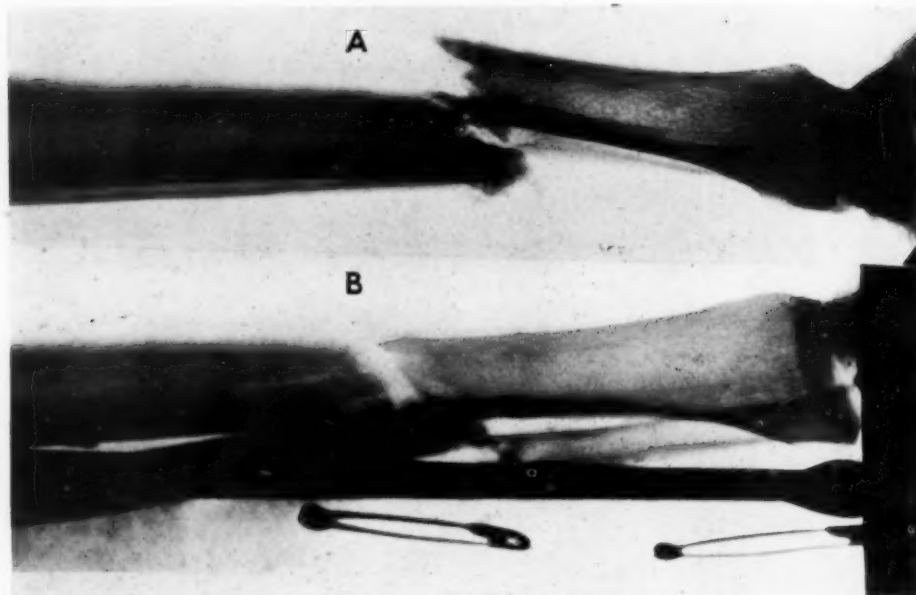


FIG. 2.—Case IIIc.

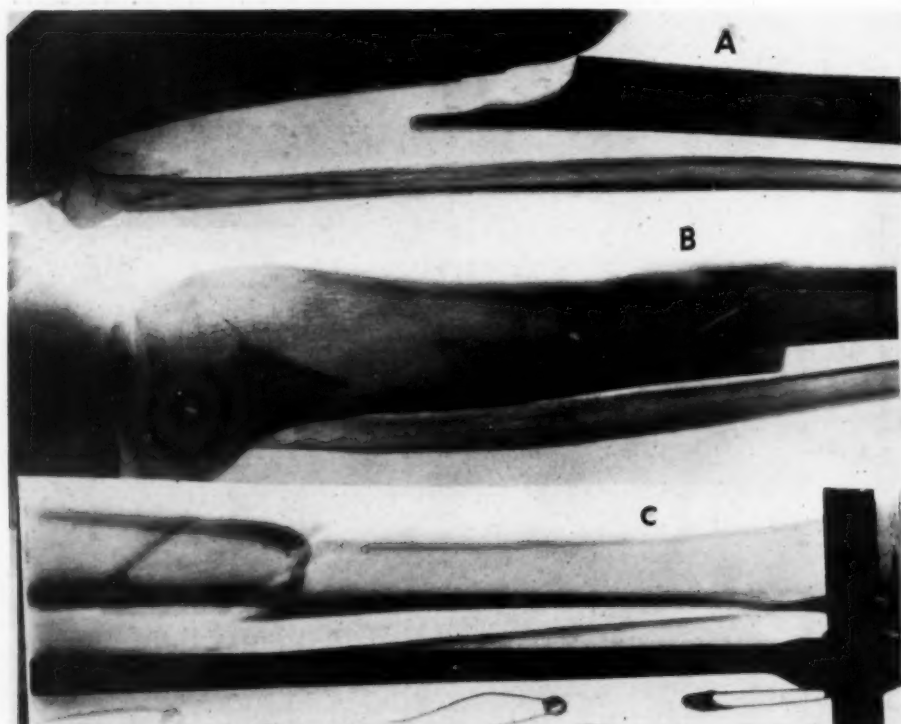


FIG. 2.—Case IVd.

FIG. 2.—(Cases Ia-IVd.) Illustrative cases showing difference since use of Böhler traction principles.

FRACTURE REDUCTION AND RETENTION

had much less trouble controlling the upper fragment, and have not had to use pressure pads over it, as formerly. Even so, the alignment is quite good as will be seen. (Fig. 2. Admitted November 30, 1930. Cast December 31, 1930. Discharged January 16, 1931.)

CASE IVd.—G. (50136). *Simple fracture of both bones of the leg, that of the tibia being in the middle third, spiral and overriding.* This limb was placed in a Böhler frame and a Steinmann pin used for traction almost from the time of admission (December 15, 1930). Note the overriding completely overcome, and the alignment maintained so that if open reduction should become necessary, as it often does in this location, the use of a bone inlay would be a relatively easy matter. It may be said here that if Case IV (Fig. 2), of 1929, had come to us in the past six months, a Kirschner drill would have been passed through the proximal tibial fragment and by upward traction at 45° with the leg, while longitudinal traction on the lower fragment was maintained, the deformity could doubtless have been corrected on a Böhler frame.

Fig. 3a illustrates the most widely used appliance of Böhler of Vienna. The photograph shows a leg in a Böhler (Braun) frame. The canvas slings under the thigh and knee may be seen. Note that the calf is permitted to sag. The Steinmann pin and caliper cannot be seen distinctly, but it will be noted that the traction cord from the calipers runs over the pulley projecting beyond the foot of the bed. Note the right angle at which the foot is easily held. On the far side of the bed will be seen a padded box against which the patient maintains his position in bed if the traction is great or he is obliged to help himself onto a bed-pan. A brick under the upper end of the frame is sometimes a convenience if the mattress is too soft, or for use while on the bed-pan. A trapeze suspended from overhead is used by the patient to help change position, lift himself while sheets are changed, etc.

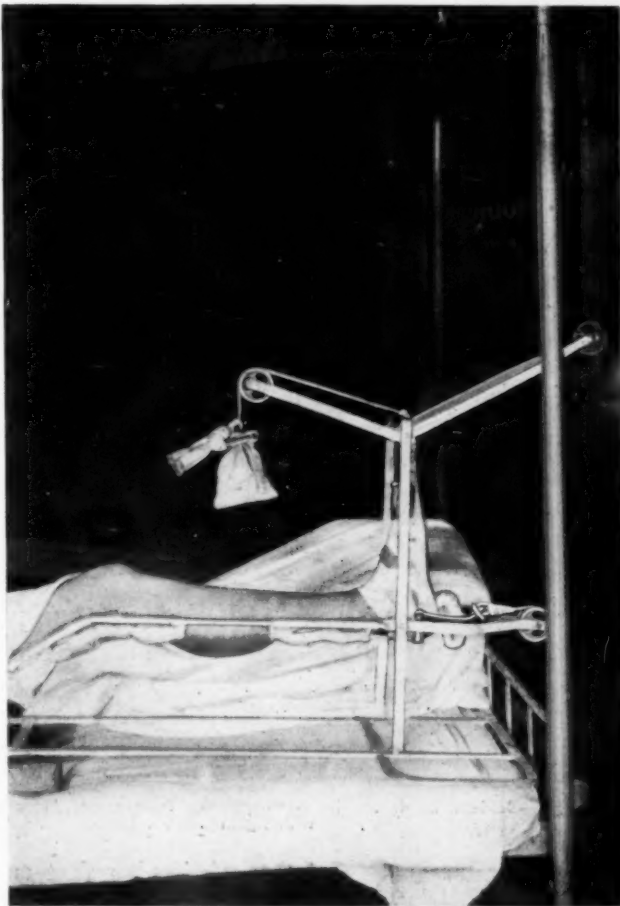


FIG. 3a.—Böhler's adaptation of Braun frame.

The photograph (Fig. 3b) shows a Böhler screw-traction apparatus with leg suspended preliminary to the application of plaster case. Notice that ordinary gas pipe was used in construction, and that a bar beneath the thigh has set screws at either end which permit its elevation and retention at any desired level. The frame may be elongated by loosening the set screws shown beneath the calf of the leg, and pulling the two ends apart. For overhead support a section of metal from a Goldthwaite frame is used as a rule, although a section of gas pipe may be held in place by bandages and has been so used by the author. A hook on a thumb-screw is shown projecting through the transverse pipe of the section extending beyond the foot. If the groin is padded and the frame pressed firmly into the crotch, a good deal of longitudinal pull may be exerted through this hook if a few

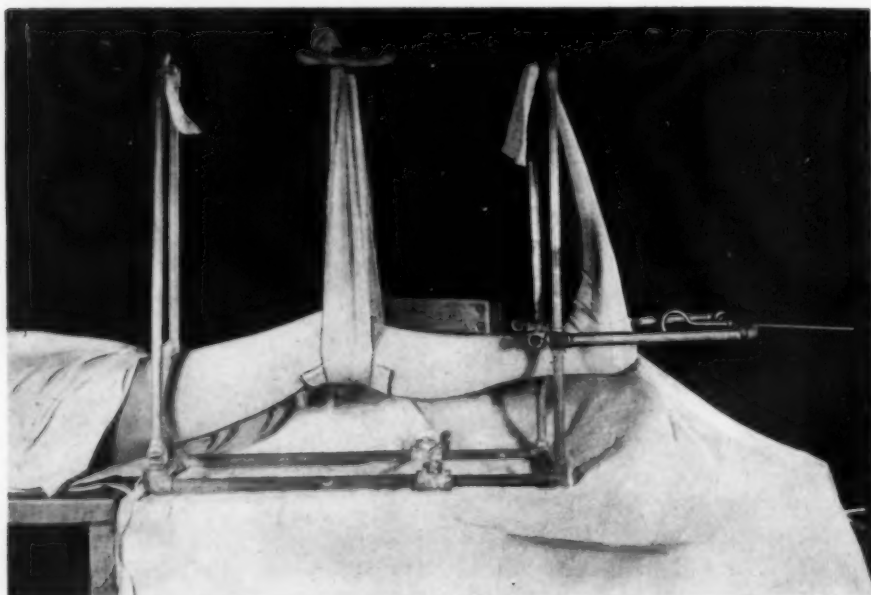


FIG. 3b.—Böhler's screw traction apparatus for fractures of leg and foot (author's adaptation), with leg in position for casting.

turns of plaster are passed through it after first encircling foot and ankle. In fact, it is expedient in certain fractures, notably of the os calcis, to leave the calipers on and attach them to the hook, thus incorporating the Steinmann pin or Kirschner drill in the plaster case.

In using the frame for fracture of the os calcis it is completely shortened, the cross bar, shown here beneath the gluteal crease, is fixed at a point coinciding with the flexed knee, and is well padded. Tongs, Kirschner drill passed through the calcaneus, with metal bow (Fig. 8b), or Steinmann pin, are then attached to the hook and energetic traction maintained until reduction is secured, when case is applied. A tenotomy of the tendon Achilles according to the method of Straus may or may not be done as a preliminary. A canvas sling under the ankle and lower leg is absolutely necessary, or

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better, a Kirschner wire through the lower third of the tibia, giving additional fixation of the leg while the flattened os calcis is being reduced by screw traction.

This frame will appeal to anyone who has much fracture work, as the back-breaking job of holding the leg, changing hands, alignment of foot, proper angle of knee and other details are all prearranged and provided for once the leg is adjusted in the frame. A nurse or one assistant to pass plaster is sufficient help for the average case.

Fig. 4 illustrates a few aids to skeletal traction. (1) The Mock-Ellis caliper for use in fractures of the phalanges, metatarsals and metacarpals, is clamped in place under local anaesthetic as a rule, and traction is secured by attaching the hook to a rubber band, and the latter to a wire loop—the so-called banjo splint.

(2) Illustrates an ordinary towel clamp which is of considerable use to reduce fractures of the phalanges, and hold the fragments until the permanent fixation, silver wire, aluminum splint or plaster is applied. Doctor Cunningham has applied traction with such a clamp at the end of the middle finger metacarpal and has by this means been able to reduce dislocated carpal semilunars.

(3) and (4), as may be seen, are made-over obstetrical forceps. The shorter one (3) is of considerable use in making adjustments through windows in a plaster case. It may be boiled and used to lift a limb surrounded by sterile dressings on a Böhler frame; to correct deformity; adjust slings, and for other purposes. It may be used to hold an arm or a leg during the application of plaster, and then may be removed through a small window by simply unlocking the forceps and removing them exactly as obstetrical forceps are removed from a fetal head. (Journal Missouri State Medical Association, pp. 578-579, December, 1928.)

(4) This forcep was originally intended for traction on the os calcis, where through-and-through wire penetration is not at first desirable owing to a longitudinal splitting of that bone. By traction and manipulation, the fragments may be brought into a favorable position for the passage of a Kirschner drill, and this used for the permanent traction. It is a convenience to have on the instrument table where traction on the leg or thigh is contemplated, and where otherwise contamination of the sterile drapes is a real danger. It may be applied to the femoral condyles, the malleoli, the os calcis, or the lower radius. Soft tissues are first displaced so that the tongs penetrate only the integument and bone.

Fig. 5 shows the Kirschner drill with one of the small-calibre wires attached. The wires have a drill point, and are rustless. I have found it best to select several wires of the sizes likely to be used, and insert one into the drill clamp prior to boiling the instrument. All that is then necessary is to prepare the skin over the desired bony point, inject 2 per cent. novocaine solution into the skin and soft parts down to the bone. The projecting wire point is readily thrust down to the bone. The crank is then turned deliberately and

not too rapidly, an assistant pressing the outermost guard against the skin, thus helping to direct the wire through the proper point, and in the proper direction.

After the wire has sufficiently penetrated, the set screw is unscrewed, the drill removed from the wire, and one of the traction bows clamped over the wire as shown at (4). A number of sizes other than those illustrated [(2), (3) and (4)] have been made at a very low cost by a local machinist.

Hooks such as shown (5) are used to connect the bow with the traction cord, or smaller hooks are used through the perforations. By means of the extra holes, off-centre pull may be exerted, thus helping to overcome lateral angulation of fragments or making up for some minor deviation in the direction taken by the wire in its penetration of the tissues.

Three of the usual sizes of rustless wires are shown, the largest being slightly smaller than the lead in a pencil. When the wire ends have been slipped into the slots on the threaded ends of the traction bow, the nuts are turned down tightly upon the wire with a wrench, and no amount of pull will bend the wire enough to cause any perceptible bowing. The excess wire may be covered with cork at either end, or nipped off with wire nippers such as shown (7). I have yet to hear a patient complain of this wire-traction method. They do not feel the wire enter the tissues, and on withdrawing it there is invariably an expression of wonder that it is out. No special preparation of the skin is needed—simply soap and water and then 7 per cent. tincture of iodine. I have not seen an infection follow the use of this drill or the Steinmann pin.

Fig. 6 illustrates a type of dressing for fractures of the humerus—especially at the surgical neck. The metal loop is incorporated in the plaster case of the shoulder and arm. In the case shown, the fracture was of the surgical neck, and about thirty-six hours old. Excellent relaxation and perfect anaesthesia were secured by the injection of 2 per cent. novocaine solution into the fracture site, and about the olecranon and upper ulna. After the case was applied as shown, a Kirschner wire was drilled through the olecranon and a traction bow attached. As will be seen, a rubber band was used to maintain the pull, and at the end of a day had separated the forearm from the upright plaster shell a full two inches. Some of this was slack taken up against the chest wall, but a good deal was traction effectively applied at the fracture site.

The author has twice applied the Kirschner wire and traction bow on an ordinary Campbell splint. Doctor Cunningham, of Oklahoma City, has a series of old dislocations of the shoulder irreducible by other closed methods, but readily reducible by skeletal traction identical with that herewith delineated. The hand should not be encased in plaster, for the traction is often great enough to draw the elbow well out and if the hand is not reasonably mobile, it will be injured in extension. It should be held against the upright by a snug, but not tight, bandage or a towel pinned about the forearm. Pulley and weights may be suspended over the out-rigging instead of using rubber if the case seems to require it.

FRACTURE REDUCTION AND RETENTION

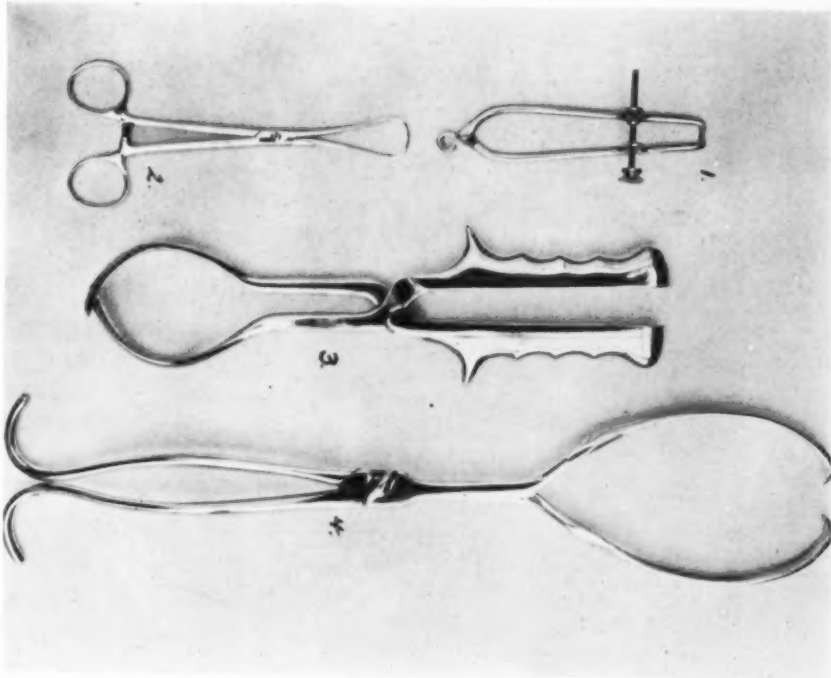


FIG. 4.

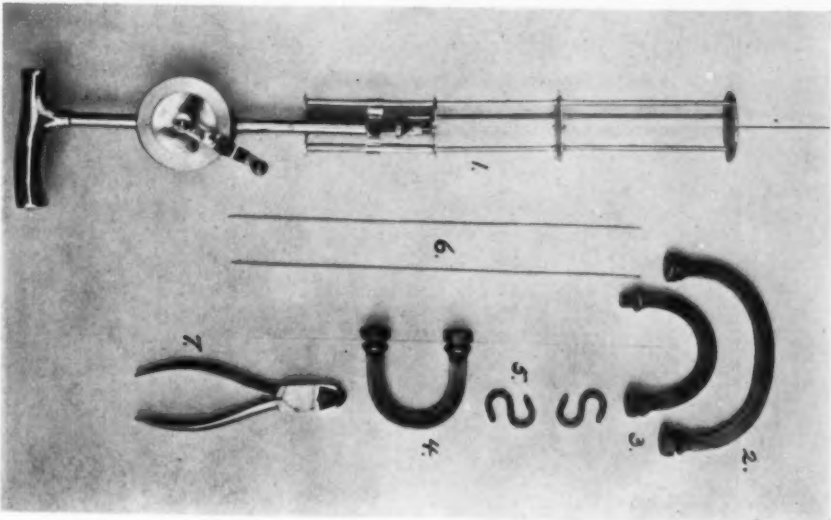


FIG. 5.

Fig. 4.—Appliances used for skeletal traction. (1) Mock's caliper for use in metacarpal or phalangeal fractures. (2) Towel clamps which may be used to accomplish reduction and then silver wire passed through the insertion of a flexor tendon attached to the wire loop to maintain extension. (3) The author's forceps for correction of position of fragments through window in plaster case; for leverage during open or closed reduction of fractures; for holding bone during plating and for use in countertraction at the lower humerus in reduction of fractures of the forearm. (4) Tongue also made from an old pair of obstetrical forceps. These have a wide range of usage in skeletal traction where no permanent extension is required, or for temporary traction during insertion of Kirschner pin or application of plaster.

Fig. 5.—(1) Kirschner drill for use in passing rustless wire through bone at olecranon, femoral condyles, tibia or os calcis. The figure shows the guards fully extended, the point of the drill projecting about 1 inch. As the drill wire penetrates the tissues the guard collapses. When penetration is complete, the drill is unscrewed and the ends of the wire are tightly clamped into notches of traction bow (2, 3 and 4) of appropriate size. (5) Hooks to connect bow to weight cord. (6) Drills of various sizes made of rustless steel. (7) Wire nippers.

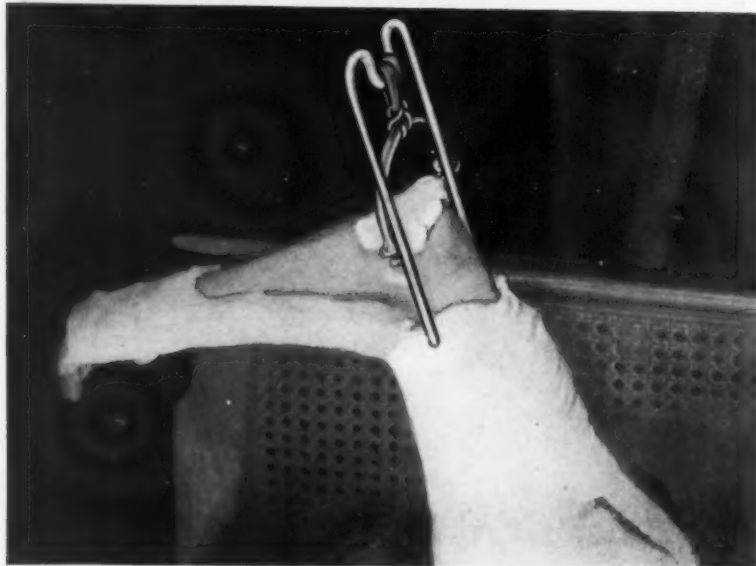


FIG. 6.

FIG. 6.—Showing method of extension for fractures or dislocation of the humerus, the Kirschner wire passing through the olecranon after method of Dr. S. R. Cunningham. The traction is maintained by rubber bands, by a turnbuckle attached to wire extending from the case as shown, or by pulley and weights.

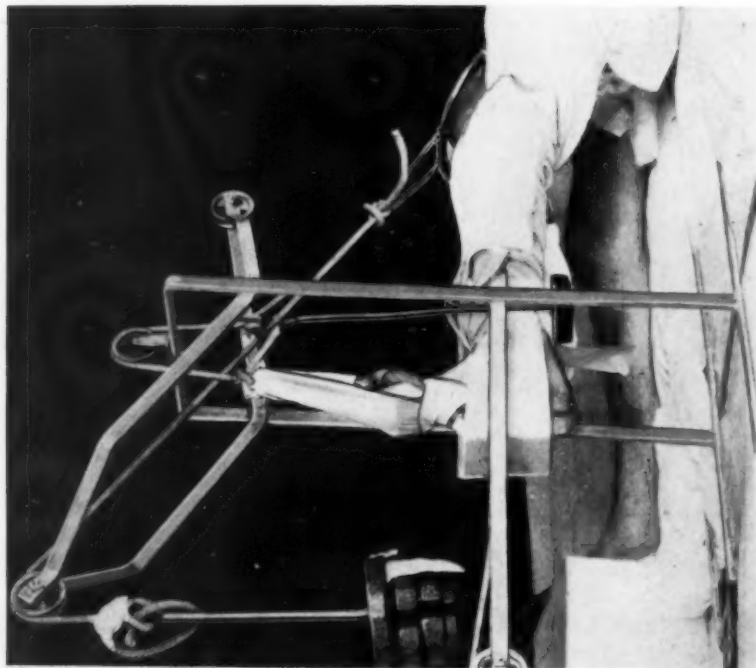


FIG. 7.

FIG. 7.—Shows method of applying extension to fractures of the femur (case of Dr. M. W. Pickard). Note that Kirschner wire through condyles is attached to traction cord in line of femur, while horizontal extension is also applied to the leg on the Böhler frame. It is seldom, if ever necessary to use both types of traction in the same individual. Note foot drop prevented by simple overhead cord through pulley fixed to frame.

FRACTURE REDUCTION AND RETENTION

There was a time when over-extension of fracture of the femur was almost impossible to attain, but with the Böhler splint and a Kirschner wire through the femoral condyles, the danger of too much traction is a real one. The ease of applying this wire drill and traction bow is nowhere so manifest, and is far more simple to use than a Steinmann pin, calipers or Böhler nail. The skin is simply iodinated at the point of entry of the wire, and a wheal of novocaine produced at this point, and at the site of exit.

Fig. 7 shows a femur up in a Böhler frame with skeletal traction at the knee and skin traction at the leg. The case was one of Dr. M. W. Pickard's and there was marked angulation at the fracture site in the middle third of the femur, with two inches' shortening. Kirschner drill was used within twenty-four hours, and during the entire time of its use, no pain was suffered from it, while the shortening was converted into a problem of over-extension. Note the various locations of pulleys, and especially the line of traction from the bow at the femoral condyles to the uppermost pulley. In cases of fracture of the femoral neck this one traction cord alone will suffice. The thigh and knee are supported on pads placed on the canvas slings, while the leg may be allowed to come down with the heel on a ring on the mattress, or sling on the horizontal portion of the Böhler frame as shown in Fig. 7. The patient may be propped nearly upright in bed, and is remarkably comfortable. The results in the few cases seen by the author are so good that it appears likely that hip spicas will soon be a thing of the past.

Where the fracture involves the femoral condyles, or there is too much comminution in the lower third of the femur, the Kirschner wire is passed through the upper tibia. In this region the peroneal nerve is to be avoided, but this is not difficult to do. The line of traction is then the same as shown in Fig. 7, except that in this type the gastrocnemius pull is best abated by more flexion of the leg than is shown. By use of the series of perforations in the traction bow, a satisfactory correction of lateral deviation is usually possible.

We come now to a consideration of a fracture, which does not usually receive adequate care even in the best hands, and authorities are pretty well agreed that 25 per cent. plus of permanent partial disability is a fairly average result. I speak of fractures of the os calcis. Böhler has made a real contribution to the solution of the problem. He places the leg in a screw-traction frame, puts a rustless nail through the lower tibia to give a secure, firm point of fixation while downward pull is being made on the os calcis, following a molding of the bone into some semblance of normal contour by a vise. The foot and leg are then encased in plaster with the pressure points well padded. Straus, of Chicago, by the use of a Steinmann pin, has accomplished much the same results, but has not provided for care of the mushrooming of the bone.

In Fig. 8a, upper figure, is shown a röntgenogram of a patient which the author treated by a combination of the methods of Straus and Böhler. The os calcis was split longitudinally, or bivalved, in such a way that a Kirschner

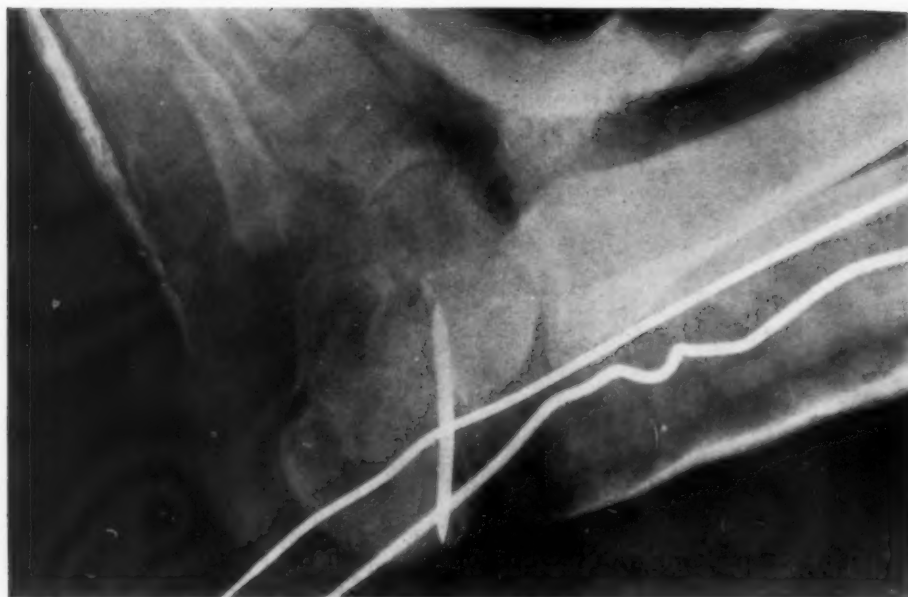


FIG. 8a.—Röntgenogram of comminuted fracture of os calcis showing Steinmann pin placed above tuberosity, and wire incorporated in plaster case of leg, to which extension was attached for downward pull on the bivalved fragments. Note the angle between foot and leg well maintained, but position of os calcis not ideal. Reduction under local anæsthetic was obligatory.

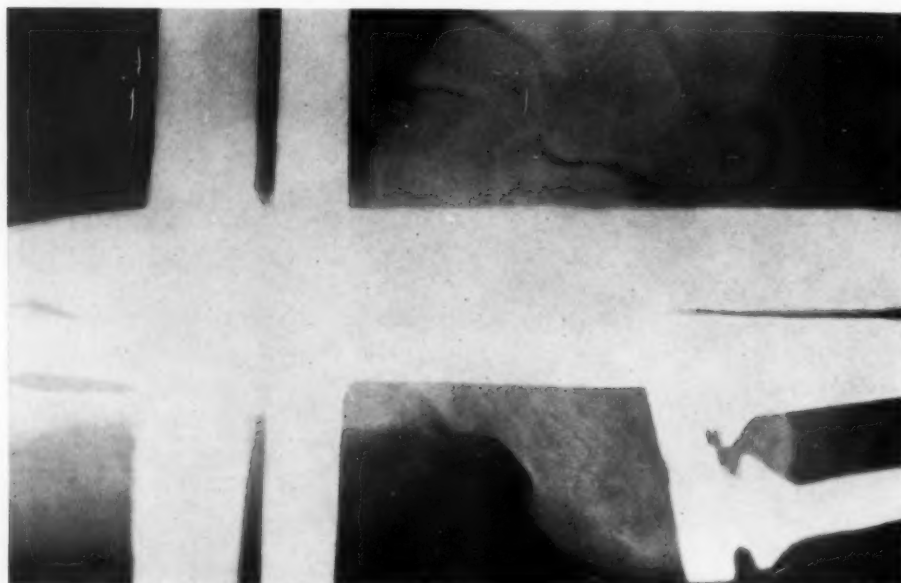


FIG. 8b.—Röntgenogram taken of one of the author's cases of fracture of the leg, showing Kirschner wire through os calcis and ideal position of foot. Note principle applicable to some os calcis fractures with or without Achilles tenotomy.

FRACTURE REDUCTION AND RETENTION

wire could not be used. Consequently, a Steinmann pin was passed through the soft parts just proximal to the os calcis, and, with the leg in a Böhler screw-traction frame, vigorous pull was made on the pin. The leg being at right angles in the frame, there is little if any tendon-Achilles pull by Böhler's method and tenotomy is seldom necessary. The röntgenogram shown is not a true lateral, but brings out the points just mentioned. Had the patient not been running a temperature of 103° to 104° , a general anæsthetic, instead of a local, would have been used, and, I am sure, much better reduction would have been accomplished. The wires incorporated in the plaster are shown, and it was to a loop made of this wire projecting downward and backward that the Steinmann pin was secured with thongs in order that traction might be maintained.

The lower röntgenogram (Fig. 8b) of another of the author's cases, put up in a Böhler frame for fracture of the tibia, shows the ideal treatment for fracture of the os calcis. The wire passing through the bone is obscured by the bolt ends of the traction bow. Note that the foot is held at right angles with the leg and the arch preserved—if not accentuated. Recently, in a compound, comminuted fracture of the os calcis, I was able to run the wire through the major fragment and attain this position reasonably well.

From what has been shown it may be seen that we are at last armed with tools that more accurately localize our efforts to the fracture site. By means of a fine wire drill, painlessly inserted at a large variety of locations, we are able to exert traction almost at will. Weights do for us what formerly could not be done, or which required the expenditure of considerable human energy. Judging from cases thus far treated, the operative work on fractures of the extremities will be reduced by half where skeletal traction and the Böhler-Braun splint are used. If the Böhler splint does nothing more than replace the pernicious and antiquated fracture box, it will have served a most worthy purpose. The Steinmann pin has always been a useful appliance, and will remain an instrument of choice in certain locations, but for simplicity, comfort and general adaptability, the Kirschner wire drill is the greatest recent addition to skeletal traction in fractures.

In conclusion, then, it may be said that our problems are gradually being solved, for certainly we have potent means at our disposal now for combating and overcoming the eight pitfalls enumerated in the early part of this discourse.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MARCH 2, 1931

The President, DR. GEORGE P. MULLER, in the Chair
CALVIN M. SMYTH, JR., M.D., Recorder

PRIMARY CARCINOMA OF THE OESOPHAGUS AND STOMACH

DR. HUBLEY R. OWEN reported the case of a man, aged sixty-one, who was admitted to the Philadelphia General Hospital August 30, 1930, complaining of difficulty in swallowing solid food. He had pain over his sternum and had lost 30 pounds in the previous three months. In April, 1929, being well, he was severely bruised in an automobile accident. He felt himself becoming gradually weaker but went to work for one month. He was then forced to cease work and was admitted to the Jewish Hospital, complaining also of a broken rib sustained in the accident. He rapidly became very constipated and had some difficulty in swallowing solid foods. He had frequently had regurgitation of food after eating. Röntgenologic examination failed to reveal any gastric lesion but did show an obstruction of the oesophagus at the level of the sixth vertebra.

Examination disclosed no tenderness, rigidity, or palpable abdominal masses. The laboratory examinations were essentially negative.

Oesophagoscopy reported that, beginning thirty centimetres from the incisor teeth, there was an irregular mass springing from the right lateral wall and filling about one-half of the oesophagus. This new growth bled easily to the touch and had the appearance of a malignant tumor.

November 3, 1930, Doctor Owen made a laparotomy exposing the stomach. A chronic infiltrating gastric ulcer about one and a half inches in diameter was found just adjacent to the pylorus, on the lesser curvature. The pylorus, ulcer, and a small amount of neighboring gastric tissue were excised. Billroth No. I operation was performed and a gastrostomy added. Microscopic examination of the specimen removed from the oesophagus by biopsy showed squamous-cell carcinoma.

The patient made a good post-operative recovery in so far as the gastric resection was concerned. After having been fed through the gastrostomy for a few weeks, he was able to swallow liquids. He gradually became weaker, however, and died January 15, 1931. Autopsy was refused.

INTUSSUSCEPTION OF ILEUM

DR. J. BERNHARD MENCKE reported the case of a man, thirty-five years of age, who was admitted to the hospital August 21, 1930. Upon the day

THYROID TUMOR OF THE MANDIBLE

before admission, while at work, he was suddenly seized with agonizing abdominal pain and vomited. When admitted he complained of pains in the lower right abdomen, with no passage of faeces or gas. He was a rather emaciated male with scaphoid abdomen and slight rigidity on the right side. An indefinite mass was to be felt on the right side. His temperature was 98.4° , pulse 112, respiration 20 per minute. His temperature never rose beyond 99.1° before operation. Upon the following day a lower right abdominal incision was made and the abdomen was found to contain a quantity of foul-smelling serous fluid. Further examination disclosed an intussusception which, by gentle pressure and traction, was reduced. It seemed as if a preliminary caecal invagination into the colon had taken place (invagination caeco-colica). When the intussusceptum had been completely drawn out, it was seen that about eighteen inches of ileum was gangrenous beginning at a point four inches from the caecum. The caecum and colon were in good condition. Some eight inches beyond the intussusceptum a nodule was felt within the ileum. The gangrenous portion was resected, using the good distal portion of ileum and an end-to-end anastomosis performed. The nodule within the ileum, a submucous fibroma one centimetre in diameter, was removed through a separate small incision. A cigarette drain was introduced to the site of the caecum and the wound closed in layers. The patient was stimulated, given saline by hypodermoclysis and by bowel, but nothing by mouth for forty-eight hours and only water for three days. The only noteworthy incident in his convalescence was an acute pulmonary infection with fever and cough on the sixth and seventh days after operation. He was discharged September 6, 1930, in good condition.

The reporter emphasized the fact that, over forty-eight hours after the onset, it was possible to perform successfully an intestinal resection utilizing a portion of gut included in the intussusception.

THYROID TUMOR OF THE MANDIBLE

DR. ROBERT H. IVY reported the case of a woman, aged fifty-seven, who presented herself November 6, 1930, complaining of a swelling beneath the mucous membrane of the mouth in the lower left molar region, of which she had only been conscious for about two weeks. This was slightly painful, and was beginning to interfere with the wearing of a lower set of artificial teeth. She felt perfectly well otherwise. At the time of examination there appeared to be nothing in the previous history which had any bearing on the case. All of her teeth had been removed many years before, and she could not recollect any previous serious trouble in the jaw. In 1923, almost eight years before, she had had a goitre operation, and had had no thyroid trouble since.

The patient was a well-nourished female, with no physical abnormalities of any consequence. There was a transverse scar on the front of the neck, the result of the goitre operation. In the mouth, which was edentulous, there was a smooth bulging of the gum tissue over the last molar region of the left side of the mandible, extending along the anterior surface of the ramus. The

swelling was normal in color. It was quite soft to palpation, was not tender, and the inner and outer plates of the bone seemed to be thinned out and slightly expanded. There was no visible or palpable enlargement of the neighboring lymph nodes, nor was any enlargement of the bone visible or palpable externally.

The röntgenogram (Fig. 1) showed a cavity in the region of the angle and ramus of the mandible, about 3 centimetres in diameter. This extended from the upper to the lower border of the bone and had clearly cut margins. There was some irregularity of the lower margin of the cavity.

The X-ray appearance and the clinical evidence were typical of a cystic condition of dental origin and a provisional diagnosis of adamantinoma was made, with also the possibility of benign giant-cell tumor in mind.



FIG. 1.—Röntgenogram showing area in region of left angle of mandible occupied by the tumor.

November 7, 1930, under ether anaesthesia, a curved incision was made in the gum over the swelling and a flap reflected outward to expose the bone cavity. This was found to be filled with rather vascular soft tissue, grayish red in color, quite unlike the dark red of the benign giant-cell tumor. As much of this tissue as possible was scooped out, though it was difficult to be sure of removing all, since the bone was perforated in several

places. The cavity in the bone was packed with gauze and allowed to heal by granulation. The patient made a good recovery and the wound in the mouth healed in about six weeks. It is too early yet to know whether bone regeneration is taking place.

The pathological report by Doctor Case was as follows:

Grossly the only striking feature about these fragments of tissue was their brownish color, suggesting thyroid tissue, though this was not thought of at the time. Microscopically, sections from these bits of tissue show thyroid gland tissue with the usual arrangement of acini and stroma. The latter is small in amount, oedematous in some areas, and it carries the blood-vessels which are sufficiently numerous to nourish the tissue satisfactorily.

The acini vary in size, in shape, in the character of their contents, and in the type

THYROID TUMOR OF THE MANDIBLE

of cell lining them. The difference in sizes range from small acini with an opening no larger than the diameter of a cell to ones many times this size, though hardly large enough to be dubbed cystic. In shape they are rounded, polyhedral, elongated, compressed, or nondescript. Fully half of the acini contain a firm, pink-staining colloid. The rest are either filled with a thin secretion, partially filled with a stringy material, or empty. (Figs. 2 and 3.) The cells are a trifle larger than one usually sees in the normal gland.

This is especially true of the nucleus which is elliptical or rounded, well-stained with hematoxylin, and having its chromatin evenly distributed in thickly set small granules. Occasionally one sees a nucleus two or three times this size. Some nuclei are deeply stained and one or two mitotic figures may be seen. In some of the large acini, the cells are moderately flattened or cuboidal but most of them are columnar, though not of the very tall variety seen in toxic goitres. Hæmorrhage has occurred in the past, for cells containing hæmosiderin are scattered through the tissue. In fact, scattered red blood corpuscles are to be found in the acinin.

Despite the unusual situation of this growth, it is improbable that it is an aberrant thyroid, and the probability is that it is a metastatic affair; yet the cells, while vigorous

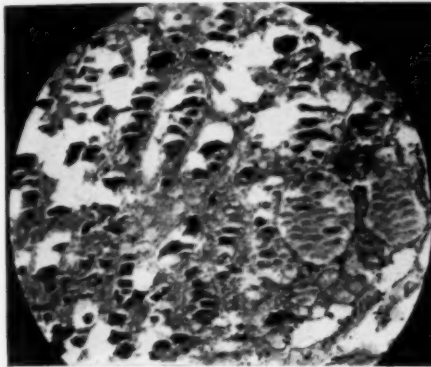


FIG. 2.—Photomicrograph, low power, of thyroid tissue obtained from mandible.

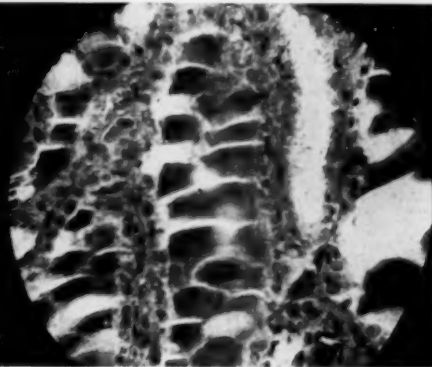


FIG. 3.—Photomicrograph, high power, of thyroid tissue from mandible.

in character, do not have the appearance of carcinoma. Taking into consideration the clinical history of the case, the diagnosis most suitable is that of a metastatic goitre.

Upon the discovery of these pathological findings, the reporter wrote to Dr. Armin Elsaesser, of Youngstown, Ohio, who performed the thyroid operation, and who reported that on February 5, 1923, the patient came to him with a goitre which she had had for twenty years, which had changed very little in size. The only complaint was a choking feeling for about two weeks previously. On February 9, 1923, the right lobe was resected. Recovery was uneventful. Examination of the tissue removed showed it to be composed largely of poorly defined glands, most of which have no acini, very few of the follicles contain colloid. In places the epithelial cells are arranged in clumps with no attempt to form gland acini. The pathological diagnosis was foetal adenoma of the thyroid.

This then is apparently a case of late metastasis of a benign thyroid tumor to the mandible. Muller and Speese in a paper on Malignant Disease of the Thyroid Gland (Univ. of Pa. Med. Bull., vol. xix, p. 74, 1906-07), state that metastasis of thyroid tumors to bone is a frequent complication. They quote Ehrhardt (Beitr. z. klin. Chir., vol. xxxv, p. 343, 1902) who mentions 65 cases, with 30 metastases to the mandible. He does not state the proportion of these that came from primary carcinomatous tumors of the thyroid, nor how many of the metastases showed malignancy. Jäger, quoted by Ehrhardt, has classified the possibility of metastases according to microscopic findings:

- (1) Cases of metastatic malignant struma in which normal thyroid tissue is present,

PHILADELPHIA ACADEMY OF SURGERY

(2) Cases in which metastasis of an apparently benign struma contains carcinomatous tissue.

(3) Cases in which it is difficult to say from the metastasis whether the struma is benign or not.

(4) Cases of metastatic benign tumors in which carcinomatous tissue could not be recognized.

The case now reported apparently belongs to the last group.

G. Blumer (Clinical Manifestations of Tumor Metastases in the Bones, Yale Med. Jour., vol. xviii, p. 153, 1911) states that the thyroid tumors which give rise to bone metastases present some very marked peculiarities. While some of them are very evidently malignant, judged from their clinical manifestations alone, others show none of the ordinary evidences of malignancy. No obvious clinical involvement of the thyroid is present in about 25 per cent. of the cases. When enlargement occurs, it is apparently an ordinary goitre which may have been present as long as thirty years before metastasis appeared. It is important to note that metastasis may not appear until three or four years after surgical removal of the gland. According to Blumer, 38 per cent. of thyroid bone metastases occur in the bones of the cranium or face. Of the facial metastases, 7 out of 9 were in the lower jaw. We have been unable to find anything significant bearing on this question in the more recent literature.

The possibility that the tissue found in this case is the development of an aberrant thyroid should also be kept in mind, although one can find no reference in the literature to aberrant thyroid tissue forming in bones.

One of the reasons for reporting this case is to emphasize the necessity of bearing in mind the possibility of a thyroid tumor in the mandible when symptoms and signs point to much commoner conditions, such as adamantinoma or benign giant-cell tumor.

FRACTURES OF THE UPPER JAW AND MALAR BONE

DR. ROBERT H. IVY and (by invitation) DR. LAWRENCE CURTIS read a paper with the above title for which see page 337.

DR. GEORGE M. DORRANCE said that no two fractures of the superior maxilla are exactly alike; hence there can be no one standardized treatment. The final results must be judged by the occlusion of the teeth. He differs from Doctor Ivy in that he believes that all fractures of the jaw should be reduced as early as possible. Doctor Dorrance finds, in his experience, that the majority of cases are best treated by the use of the interdental splint made from a cast of the jaws. He feels that the antrum should be drained in all fractures of the superior maxilla because blood clots or pus pockets are of frequent occurrence there.

DR. LAWRENCE CURTIS disagreed with Doctor Dorrance regarding drainage of the antrum. He believes in letting the accessory sinuses alone and has obtained just as good results by so doing. He has never had any trouble from antrum infection, and if trouble does present itself it can be dealt with at that time. Doctor Dorrance said he reduced these fractures immediately. Doctor Curtis also does this if he can, but there are certain cases in which one does not wish to cause any additional pressure. As to the plaster head cap, the speaker uses the one designed by Major Scogin which is not at all uncomfortable. It is made of two layers of stockingette between which there

INTERNAL DERANGEMENTS OF THE KNEE

are strips of felt to take pressure off the bones of the skull. Patients very rarely complain of this type of dressing.

INTERNAL DERANGEMENTS OF THE KNEE

DR. B. FRANKLIN BUZBY read a paper with the above title for which see page 397.

DR. W. G. ELMER said that, several years ago, when the American College of Surgeons was meeting in Boston, Doctor Osgood conducted an operative clinic in the Massachusetts General Hospital which has an exceptionally large surgical service; as he was about to operate upon a patient with loose bodies in the knee-joint, he stated that he had recently tabulated all of the operations that had been performed upon the knee-point in the hospital over a period of twenty years and found the total number was 220, or an average of ten a year. This would indicate that the operations for internal derangement of the knee-joint are rather infrequent and Doctor Buzby's series is a valuable contribution. In regard to X-ray examination for loose bodies in the joint, it is Doctor Elmer's practice to specify on the X-ray request sheet a very soft film—an exposure such as is made in studying the pathology of the lung for example, and usually the faint shadows of the loose bodies can be seen. In the usual exposure which is made for bone pathology they are lost altogether.

DR. A. BRUCE GILL said that he desired to emphasize a point made by Doctor Buzby, that if operation on a knee-joint is necessary it should not be delayed. When a patient suffers repeated injuries to the knee, as, for example, the repeated "slipping" of a semilunar cartilage, a marked condition of chronic synovitis may result. If, eventually, the cartilage is removed the knee may remain painful, swollen, tender and with limited function indefinitely. In other words, the pathology in the knee was not confined alone to the cartilage. These important secondary changes in the knee-joint are caused by repeated traumatism and could be prevented by earlier operations on the cartilage. Doctor Gill has seen in such knees thickened injected synovial membrane and pannus formation growing over the articular cartilage of the femur fairly frequently in long-standing cases of repeated traumatism, and believes that one should advise exploratory operations on the knee oftener and earlier than has been customary.

Injury to the ligamentum mucosum or sub-patellar pad of fat is relatively frequent, and after repetition of such injury the alar ligaments, or lateral borders of this structure, become enlarged and greatly indurated. Such pathology causes marked pain and marked disability in the knee-joint. These thickened structures should be excised without delay.

Injury to the crucial ligaments is probably not so uncommon as Doctor Buzby states. It is usually accompanied by injury of the lateral ligaments of the knee and is evidenced by preternatural mobility. Normal function of the knee may usually be restored by some operation to strengthen the lateral ligaments, particularly the internal, such as plication of the ligament with fascia lata suture.

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD APRIL 6, 1931

The President, DR. GEORGE P. MULLER, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

ACUTE OSTEOMYELITIS IN AN INFANT

DR. FREDERICK R. ROBBINS reported the case history of a white male child of ten months, who was admitted to the Children's Hospital August 22, 1930. The mother stated that he fell from his bed four days before admission. The next day he became very sick and cross and cried and coughed a great deal. The following day he was apathetic and on the day before admission he vomited three times and his cough continued. Previously the child had been healthy, weight at birth being seven and three-quarter pounds.

Examination revealed a child acutely ill, with a respiratory rate of 45 per minute. The patient's general state gave the impression of a right lobar pneumonia.

On the following day the entire right arm was greatly swollen, hot, painful and indurated, the swelling and tenderness being more marked in forearm and elbow. The left fourth finger also was swollen and tender. The patient was transferred to Doctor Lee's service, with the diagnosis of acute osteomyelitis of the right ulna and left fourth finger. At operation much pus was found under the periosteum of the lower end and in the marrow cavity of the right ulna. The soft tissues of the left fourth finger were also incised and pus obtained. Following the operation, the patient showed signs of severe shock.

On the eighth day the child's general condition was poor. The left upper arm and axilla were swollen and indurated. These were incised and pus obtained. On the eighteenth day the patient continued to lose weight and the wound in the left arm was enlarged. On the twenty-first day incisions were made for multiple abscesses of scalp. General condition was poor. On the twenty-fourth day the outer aspect of the left thigh was swollen and tender. This was incised and much pus evacuated. On the fifty-fourth day the diagnosis of bilateral otitis media was made. Both ears were incised followed by drainage of pus. On the fifty-fifth day the left ear was reincised. On the sixty-first day the right ear was reincised and a mastoidectomy was advised by the aurist but was not done because of the patient's condition.

From the sixty-third to the eighty-first day it was necessary to reincise the right forearm four times.

An X-ray of the entire right ulna now showed changes, typical of advanced osteomyelitis with sequestrum formation and marked involucrum formation; also osteomyelitis and pyogenic arthritis of the left fourth finger.

On the one hundred fourth day the X-ray showed infection of the right mastoid. On the one hundred fifth day the patient developed measles and was referred to the Municipal Hospital.

The laboratory findings showed very little secondary anaemia, probably on account of frequent blood transfusions. The leucocytes varied from

DIAGNOSIS OF BREAST DISEASES BY X-RAY

29,000 at onset to 6,900. The Wassermann was negative. Pus from all of the wounds showed streptococcus hæmolyticus, but no growth was obtained from blood culture. The pulse rose as high as 176; the respirations to 58; and temperature to 105°.

On the one hundred sixteenth day following the first admission, the patient was readmitted from the Municipal Hospital in the service of Doctor Speese, at which time there was slight drainage from the right arm and considerable drainage from both ears. The child was playful and happy. X-ray was suggestive of bilateral mastoid infection. On the one hundred twenty-seventh day the patient was discharged to the Ear Dispensary. Mastoidectomy was not done.

When the patient was discharged from the dispensary one hundred forty-five days after first admission, it weighed 20 pounds, 4 ounces and was in excellent condition.

Doctor Robbins remarked that it was unusual for one so young to have acute osteomyelitis and to recover in spite of so many foci of infection. Although the blood culture did not show it, there was evidently a blood-stream infection, for the same type of organism (streptococcus hæmolyticus) was recovered from each focus.

The child, at first, in spite of all treatment, including daily hypodermoclysis and frequent blood transfusions of the mother's immunized blood, rapidly lost weight and became more toxic, until one nurse took a particular interest in him, gave him special nursing and fed him all of his meals. It was remarkable how promptly the child responded to this personal and sympathetic treatment and from that time on he seemed happy, and rapidly improved and gained in weight. He felt confident that the recovery of this patient was due to the attention of the pupil nurse who took care of him.

DIAGNOSIS OF BREAST DISEASES BY X-RAY

DR. PAUL S. SEABOLD, by invitation, remarked that a study of the female breast has been made by a röntgenographic method whereby it is possible to demonstrate the changes in architecture of the breast as seen in the normal organ during the cycles of both menstruation and pregnancy. In the pathologic breast a differential diagnosis may be made in benign and malignant tumors, particularly malignant tumors with metastasis. There is no doubt but that this method is quite helpful in early border-line cases where malignancy is suspected. A paper giving the full details of this study is now in press. To illustrate his remarks, the speaker demonstrated röntgenograms as follows:

CASE I.—Normal breast. Aged twenty-five, sixteen days following menstruation; duration of period, five days; no children; no miscarriages; not married. This case demonstrated the normal triangle of the breast with its apex at the nipple and base at the pectoral fascia. This triangle is made up of linear striations all converging to the nipple with fringed lacelike waves lying at right angles giving a surflike appearance. It is the disarrangement of this linear architecture that gives us our aid in diagnosis of the various pathologic conditions of the breast.

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CASE II.—Normal breast during the menstrual cycle. Aged thirty-one, seven days before and seven days after the onset of the menstrual flow; duration of period, four days; one child 1½ years, twins two months; not lactating at the present time. Radiographic examination shows the normal breast is at its height of epithelial hyperplasia seven days before the onset of the menstrual flow and at its lowest ebb seven days after the onset of flow. The increase in the opacity of the surflike appearance is parallel with the hyperplastic function.

CASE III.—Normal breast during pregnancy. Aged twenty-one, films made seven day before delivery and fourteen months after delivery; two children; no miscarriages; not lactating at present. The normal breast during pregnancy shows the same changes in architecture as are seen in the menstrual cycle, only to a far greater degree, for the actual histologic changes are the same as those seen during the menstrual cycle.

CASE IV.—Aged twenty-eight, ten days following menstruation, duration four days; no children; no miscarriages; not married. The films made on this patient show a circumscribed, localized opacity with a definitely defined border. The opacity appears to be crowding the linear striations to the side as well as the surrounding breast tissues. This is entirely different from the carcinomatous extension, which is by invasion instead of crowding. *Radiographic diagnosis.*—Benign tumor. *Pathologic Diagnosis.*—Fibro-adenoma.

CASE V.—Benign tumor in a male breast. Aged sixty-seven; no history of trauma. This case clearly demonstrates a sharply defined opacity bordered by a fine line parallel with its circumference, which, no doubt, represents the capsule of the tumor. There is also a general tendency to the crowding of the linear striations. Axillary and pectoral areas are free from metastatic opacities. *Radiographic diagnosis.*—Benign encapsulated tumor. *Pathologic diagnosis.*—Encapsulated fibro-adenoma.

CASE VI.—Carcinoma with metastasis. Aged fifty-eight, two children; no miscarriages; menopause five years ago. The radiographic examination of this patient shows the penetrating process of invasion which is so typically noted in malignant tumors, particularly carcinoma. There are also a number of small irregular areas of opacity in the vicinity of the pectoral and axillary lymph-nodes. These are metastatic malignant nodes.

CASE VII.—Carcinoma superimposed on abnormal involution with metastasis. Aged fifty-three, one child, no miscarriages, menopause one year ago. These films show a general irregular appearance throughout both breasts, which is dotted in character. These characteristic dotted opacities are typically found in abnormal involution. Superimposed on this condition there is also noted an invading opacity in the deeper portion of the breast. There are also distinctly localized opacities in the axillary lymph-node area suggesting malignant metastasis. *Radiographic diagnosis.*—(1) Carcinoma with metastasis. (2) Abnormal involution both breasts. *Pathologic diagnosis.*—(1) Scirrhus carcinoma. (2) Abnormal involution.

CASE VIII.—Calcified axillary lymph-nodes. Aged thirty-seven, no children, no miscarriages, not married. The lymph-nodes shown in these films are distinctly well defined and intensely opaque, while those of malignant metastasis are very faint and ill defined. *Radiographic diagnosis.*—Calcified lymph-nodes of tuberculosis.

DR. J. STEWART RODMAN said that any attempt to make diagnosis more exact is certainly praiseworthy. Being a surgeon, however, he is not sure but that sometimes X-ray men have somewhat vivid imaginations. He does believe, however, that he could follow some of these conditions outlined on the plates by Doctor Seabold. The clinical diagnosis of carcinoma of the breast and chronic cystic mastitis is not ordinarily difficult, and therefore until we have X-ray evidence of more positive value we had best go a little slow in accepting evidence which is contrary to clinical findings. The most

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important field for such help is to decide between the physiologic and pathologic changes in the mammary gland. If this method can be developed to the point that the evidence will tell the difference between these two conditions with reasonable certainty, then it will be a great step in advance.

CANCER OF THE UTERUS

DR. JOHN B. DEEVER read a paper with the above title for which see page 381.

DR. FLOYD E. KEENE said that the treatment of carcinoma of the cervix can be readily subdivided under three headings, namely, prophylactic, palliative and curative. It is a well-accepted fact that carcinoma usually develops in a cervix which has been traumatized by childbirth or has been the seat of a chronic inflammation. Such being the case, it is undoubtedly true that the incidence of cervical carcinoma can be very decidedly lessened by measures taken to the cure of these lesions.

Pemberton reports 5,962 cases in whom the cervix had been repaired or cauterized and only five subsequently developed carcinoma. Huggins reported 2,985 cases subjected to excision by the endothermic knife and in none of these did carcinoma develop. In a series of 300 consecutive cases of carcinoma of the cervix, Farrar reports that 288 had had either full term or premature pregnancies and in only nine had a cervical repair been done.

In spite of extensive propaganda against cancer, malignancy of the cervix is rarely seen during the early stages, and in the majority of cases by the time the patient presents herself for treatment the lesion has passed beyond the stage of cure, by either operation or irradiation.

In this large group of cases there is no method which offers as much in the way of palliation as radium. By its use, local healing will follow in 60 to 65 per cent. of cases, as a result of which there is at least a temporary cessation of bleeding and foul discharge, and not infrequently there is a temporary relief of pain. It is a mistake to use radium in cases where the involvement is very extensive. Under such circumstances irradiation is of no benefit and, not infrequently, it may aggravate the suffering. Difference of opinion still exists as to whether irradiation or operation is the preferable procedure in the treatment of stage I and possibly the stage II cases. Statistics are available which would seem to favor either one of these methods. For example, Sir Victor Bonney reports a 54.3 per cent. five-year cure in stage I, gland-free cases. Weibel reports a 40 per cent. five-year cure in cases of early lesions. When glandular involvement was present at the time of operation, only 10 per cent. were alive and well after five years.

In an extensive study, based upon the results obtained in the various European clinics, Heymann gives the following data: In twenty clinics, operation had been performed on 5,024 cases, and in seventeen clinics, irradiation had been employed in 3,512 cases. The total salvage from operation was 18 per cent. and from irradiation 16.3 per cent. The five-year

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cures in the operable and border-line cases were 35.6 per cent. from operation and 34.9 per cent. from irradiation. There was a primary operative mortality of 17.2 per cent. and an irradiation mortality of 2 per cent.

The best results that have been reported in this country from the use of irradiation are those of Ward, who obtained a total salvage of 23.1 per cent. with five-year cures of cases of stages I and II in 53.1 per cent. Heymann with similar treatment reports a total salvage of 22.4 per cent. and in stages I and II, 44.4 per cent. In his own clinic, cautery excision and radium have given a five-year cure in 42.9 per cent., with a total salvage of 13.7 per cent.

DR. CHARLES F. NASSAU said that he believed that the use of X-rays across the abdominal cavity is frequently productive of damage. Certainly in the hands of an expert the rays can be directed toward the prostate so that a recurrence can be taken care of but on at least two occasions the speaker has seen extensive adhesions of the bowel following this treatment in cancer of the uterus. In operations for obstruction of the bowels after X-ray treatment of the uterus it is practically impossible to separate the adherent coils of intestine. One patient recently operated upon in this city went to a röntgenologist of her own volition. She was having bleeding from the uterus and it was supposed that she had cancer; perhaps she did. Later she came to Philadelphia and went to another who continued the treatments. She was finally operated upon for obstruction and the surgeon spent two hours trying to relieve the adhesions and did not succeed.

DR. JOHN B. DEEVER remarked that the important point is to get the cases early and particularly those with laceration and erosion of the cervix, *etc.* The treatment is too often determined by the röntgenologist and the family doctor, rather than by the experienced surgeon or the gynecologist, who should be much better able to decide the question of surgery or radiation. Even surgeons of long experience find difficulties sometimes in determining the line of treatment to pursue. The general impression held by the laity that radium and X-ray will cure carcinoma is wrong. Only certain types of carcinoma are amenable to radium and X-ray and the truth should be given the laity. However, enthusiasm is sometimes not tinged with the best judgment.

CHOLECYSTOSTOMY, ITS INDICATIONS AND RESULTS

DR. E. L. ELIASON and (by invitation) DR. L. K. FERGUSON read a paper with the above title for which see page 370.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 25, 1931

The President, DR. EDWIN BEER, in the Chair

ENDOTHELIAL MYELOMA OF TIBIA; LONG-STANDING CURE BY TOXIN TREATMENT

DR. WILLIAM B. COLEY presented a man, thirty-one years of age, who was admitted to the U. S. Marine Hospital, on Staten Island, February, 1918, with a history of an injury to the left tibia. The surgeons of that institution, Doctors Christian and Palmer, conducted the subsequent care of the case, which was reported by them in the *Military Surgeon* of July, 1927. It was later republished by Doctor Coley in the *Amer. Journ. of Surgery*, February, 1928. Now that five years have elapsed since the beginning of the toxin treatment, Doctor Coley desired to present him before the New York Surgical Society.

In September, 1925, a midhigh amputation was done. The microscopic diagnosis of the growth, in which all pathologists concurred, was myelosarcoma.

Very rapid generalization of the disease followed amputation. Eleven weeks later a nodule was observed just above the umbilicus. A biopsy was performed, and a pathologic diagnosis of myelosarcoma, metastatic, was made.

By January 5, fourteen weeks after the amputation, there was found a "tumor mass the size of a man's fist on the inner aspect of the stump with an additional growth the size of a lemon on the outer aspect." The skin was normal. There was a mass in the inguinal region, two inches long and two inches thick; also there was another small mass just above the umbilicus.

At this time, January 5, 1926, Coley's toxins were begun in doses of $\frac{1}{4}$ of a minim, increased daily by $\frac{1}{2}$ minim, up to $6\frac{1}{2}$ minims. At first the temperature reactions were quite severe but later tolerance was established, and slight reaction followed the larger doses. By January 22, the circumference of the stump had decreased from nineteen inches (at the beginning of treatment) to seventeen inches. The mass in the groin had disappeared. "The mass above the umbilicus was smaller, softer and lighter in color." The dose was held at $6\frac{1}{2}$ minim from January 25 to February 2, 1926, and then increased by 1 minim daily until he was receiving 18 minims daily. The toxins were discontinued on February 20 because of extreme weakness of the patient. "At this time the stump had taken on new growth" with considerable oedema of both good leg and stump. By March 17 the supra-umbilical growth had increased to the size of a large lemon. *Röntgenogram* on February 23 showed that the stump of the femur had undergone almost complete dissolution.

On March 27, the toxin treatment was resumed; the dose, 2 minims, injected into the tumor-mass in the stump, was increased daily up to 5 minims; marked reactions followed.

By May 5, 1926, several small nodules had appeared under the skin of the abdomen. During May and June the patient grew steadily worse, metas-

tatic growths appearing in many parts of the body; there was considerable involvement of the right clavicle, and multiple tumors in the scalp, cranial bones and cervical vertebræ. About this time the maximum growth of the tumor in the stump was attained; the circumference was thirty-one inches (an increase of fourteen inches since January 22). The end of the stump had broken down over an area of five inches in diameter, from which there was a profuse, foul, and ichorous discharge.

August 5, 1926, Coley's toxins were again begun; the dose of 2 minims was increased daily by 1 minim until 17 minims were reached. This was given daily until September 4. By this time the improvement was very marked. The stump was much smaller, the supra-umbilical mass had practically disappeared; the areas of involvement of the scalp had disappeared, and the clavicular tumor had decreased considerably in size.

An additional series of toxin injections was begun on September 19 and continued for three weeks. On November 22, the general condition of the patient was excellent; his weight was 147 pounds, a gain of 30 pounds since January 22; the stump was seventeen inches in circumference, a reduction of 14 inches since May. The old wound of the stump had entirely healed, the growths of the abdomen, groin and scalp had disappeared, and the right clavicle showed only some degree of thickening and roughening. The patient was discharged from the hospital December 5, 1926, apparently entirely well.

In February, 1927, he received further treatment with the toxins, a dose of 3 minims increased every third day until he was getting 30 minims.

After the case was published in July, 1927, a still further series of injections was done in October, 1927. He has remained in excellent health ever since and has had no evidence of the disease either in the bones or soft parts. It is now more than five years since the treatment was begun.

DOCTOR COLEY said that in view of the remarkable recovery, the pathology of the tumor has aroused a good deal of interest. The case has been classified by the Bone Sarcoma Registry committee (Case No. 1143) as a Ewing's sarcoma. The microscopic sections have been examined by a number of pathologists. Regardless of the diversity of opinion as to the classification of this tumor, all agree that it is a highly malignant tumor. No matter what the classification is, there is no doubt that they were dealing with a highly malignant tumor with numerous metastases to both bone and soft parts, which has been cured by Coley's toxins alone without any other form of treatment.

ENDOTHELIAL MYELOMA OF THE FIBULA; METASTASES. AMPUTATION. TOXINS FOR THREE MONTHS. PERMANENT RECOVERY.

DOCTOR COLEY presented a youth who, at the age of eight years, was admitted to the Hospital for Ruptured and Crippled in March, 1920. He had always been well until January, 1920, when he received a severe blow on the outer side of the right leg. Shortly after he began to have pain in the leg, and a few days later a swelling developed which increased rapidly in size. An exploratory operation showed some pus and marked thickening of the bone; this was extensively curetted. The tumor grew very rapidly after the operation, and became fungating. Doctor Coley saw the patient for the first time in June, 1920, when there was a large tumor occupying the lower two-thirds of the fibula, fungating over the central portion. The glands of the groin were markedly enlarged.

Amputation was performed by Dr. Armitage Whitman in June, 1920, immediately after which the toxin treatment was started. The pathologic diag-

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nosis of Doctor Jeffries was round-cell sarcoma of periosteal origin, and that of Doctor Ewing was endothelioma.

The toxins were given systemically, every other day, in doses increased to the point of producing a marked reaction. The glands of the groin decreased somewhat in size but did not disappear. One of these was removed and pronounced of the same type as the primary tumor. The toxin treatment was kept up until the middle of August when the patient was allowed to go to the country. Reëxamination on October 23, 1920, showed the inguinal glands had increased in size, and a hard mass the size of a child's head was discovered in the right iliac fossa. A röntgenogram of the chest was taken at this time and a diagnosis of pulmonary metastasis was made by Dr. Ralph Herendeen, the röntgenologist of the Memorial Hospital.

October 27, 1920, the patient was given one radium-pack treatment, 10,109 millicurie hours placed at 7 centimetres' distance over the right iliac fossa. No radiation was given over the chest. The parents were urged to leave the child in the hospital for further treatment, but as a hopeless prognosis had been made, they insisted upon taking him home without delay. In the early part of May, 1921, the patient's father reported that the boy was still alive. He was in perfect health and attending school regularly. He has remained well, without further treatment of any kind, up to the present time, nearly eleven years later. A röntgenogram taken in October, 1921, failed to show any evidence of the disease in the lung.

This patient furnishes another example of an extensive endothelial myeloma with multiple metastases that has recovered and the patient remained well for more than five years. The diagnosis of the Bone Sarcoma Registry (see Case No. 267) was that of Ewing type of sarcoma.

GIANT-CELL SARCOMA OF RADIUS; TOXIN TREATMENT; WELL THIRTEEN YEARS

DOCTOR COLEY presented a man, aged twenty-nine years, who first came under his care in April, 1918. Eight years previously he had sprained his wrist, but had apparently completely recovered. In November, 1917, he noticed a sharp pain like the prick of a needle in the left forearm; two months later he had loss of power in the left hand, and at the same time he noticed an enlargement of the lower portion of the left forearm, extending down to the wrist. The tumor was apparently primary in the radius, involving the lower three inches. The whole wrist was enlarged, the circumference being two and one-half inches greater than the normal side. There was apparently some thickening of the ulna as well. A pathologic fracture of the radius, and almost complete fracture of the ulna as well, had occurred. The skin was normal, not adherent. The tumor was soft, semifluctuating in consistence. X-ray showed complete destruction of the radius for a distance of three inches. Amputation had been advised and the patient had given his consent.

It was decided to try systemic toxin treatment first and he was accordingly admitted to the Hospital for Ruptured and Crippled April 25, 1918. By the end of June the swelling had nearly disappeared, and by the end of July it had entirely disappeared. The patient remained in the hospital for only three months, he was treated as an ambulatory case for the next five months, returning two or three times a week for moderate doses of toxins. The improvement was continuous, and at the present time, thirteen years after the treatment was begun, the patient remains in good condition with no evidence of a recurrence. The diagnosis of the Bone Sarcoma Registry (see Case No. 211) was that of benign giant-cell tumor.

This case shows that it is possible to cure a very extensive giant-cell tumor of a long bone even after the bony shell and a considerable portion of the bone have been destroyed; and that it is possible to accomplish this with a much shorter period of disability than is ordinarily required for treatment by radiation. Furthermore, this and a number of similar cases treated by toxins alone prove that resection of the bone, as advocated by Bloodgood and others, in the treatment of giant-cell tumors, is entirely unnecessary, for once the disease is cured or eradicated, practically complete regeneration of bone follows with full restoration of function.

DOCTOR COLEY said that he presented these cases that evening because, so far as he knew, there were no cases in medical literature comparable to them, that have been successfully treated by any other method of treatment. Other recoveries under the toxins, quite as remarkable as these, could be cited.

He hoped that the end-results obtained might be sufficiently convincing to cause a much wider use of the method, not only in inoperable metastatic bone sarcoma but in the earlier stages of the disease when it is possible to save the limb as well as the life of the patient. In the first case presented this evening, the Marine Hospital case, the limb in all probability might have been saved had the toxins been used before amputation.

It should be clearly understood that he did not advocate the use of the toxins in all cases of bone sarcoma. They had learned by long experience that in the osteogenic type, with much new bone formation, neither toxins nor radiation have a marked effect. If such cases are treated by conservative methods one not only fails to save the limb but greatly lessens the chances of saving the life by the delay incident to such treatment. These cases should have immediate amputation followed by prolonged prophylactic toxin treatment. This method, in his experience, had resulted in about 50 per cent. five-year recoveries.

It is the highly cellular bone tumors of the osteolytic type, with little new bone production, the endothelial myelomas or Ewing sarcomas, that afford the most promising field for the use of Coley's toxins; furthermore, these tumors are highly radiosensitive. This would, theoretically, seem to justify the use of the combined method of treatment, *i.e.*, toxins and radiation. A recent analysis of eighty-six cases of this type observed at the Memorial and the Hospital for Ruptured and Crippled shows twenty-two alive and well beyond the five-year period. Only one case recovered under radiation alone although primary radiation was employed in no less than thirty-four cases.

In spite of these superior results following the use of Coley's toxins, most of the recent literature on bone sarcoma omits any mention of the method. The poor results of surgery have been stressed so much that there is at present a growing tendency to treat all types of bone sarcoma by radiation, and this in spite of the fact that few of the men who are using this method have any idea of the end-results of such treatment. He believed the Memorial Hospital to be the only hospital that has treated a sufficiently large number of cases of operable sarcoma of the long bones by radiation, with a careful fol-

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low-up of the end-results, to warrant a definite conclusion as to the value of radiation. Up to the present time they have not had a single five-year recovery of an osteogenic sarcoma treated by primary radiation, and the series treated by amputation following radiation gave a much smaller percentage of cures than did the earlier series treated by amputation followed by toxins. In 1928, they abandoned radiation as the primary method of choice in osteogenic sarcoma and have since treated these cases by amputation and prophylactic toxins. These facts are apparently not known or little heeded, for within a few months there came under his care a case of osteogenic sarcoma of the femur that had been treated for seven months by radiation alone at one of the largest and best of the metropolitan hospitals. The diagnosis of osteogenic sarcoma had been confirmed by biopsy at the beginning of treatment. The biopsy wound had never healed but had gradually become enlarged and was fungating, and subject to repeated small hæmorrhages. His condition was so far advanced that no treatment other than palliative was given. He died about two months later from exhaustion and repeated hæmorrhages; and the autopsy showed absolutely no metastases. In this case, an amputation performed when the diagnosis was made, would, undoubtedly, have saved the life of the patient, and yet he was given seven months' treatment by radiation, a method of treatment that has practically never cured a bone sarcoma of this type.

Their statistics show that of 121 cases of operable malignant tumor (osteogenic sarcoma and endothelioma, exclusive of giant-cell tumor) of the long bones treated by radiation as the primary method of choice, sixty-two became inoperable or developed metastases while undergoing treatment. Only one case recovered and remained well for five years. Unfortunately, in this case no microscopic examination was made. While the diagnosis made at the Hospital for Ruptured and Crippled, before the patient was transferred to the Memorial Hospital, was that of osteomyelitis, the Bone Sarcoma Registry has classified this as a case of endothelioma.

Of another group of fifty-nine cases in which amputation had to be performed after failure to control the disease by radiation, six have remained well for a period of five years, so that, of a group of 121 cases treated primarily by radiation, we have 7 or 5.78 per cent. well for five years or more.

DR. HERMANN FISCHER said that fourteen years ago Doctor Coley treated a patient, referred to him by the speaker, a young man who developed a tremendous tumor of the thigh after an accident in which he broke his left leg in stepping off a train. At the time Doctor Fischer saw him he was in an apparently hopeless condition, with a temperature of 104°-105°. Doctor Coley was called in and even he regarded the case as an impossible one, but the patient was cured absolutely and is still alive and well after fourteen years. It is a sin of omission not to use the Coley serum in these cases.

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DR. ALLAN O. WHIPPLE said that the cases in which the serum has been used at the Medical Centre had not responded to the treatment. In using the fluid, if the patient shows no evidence of response to the ordinary dosage, should it be increased notwithstanding the patient's marked reaction? Also, whether in the Ewing type of tumor with metastasis would one be justified in pushing the dose to the same point as was done in the case treated at the Marine Hospital?

DR. BURTON J. LEE explained that Doctor Coley, in stating that radiation had been given up at the Memorial Hospital, referred to the osteogenic sarcomas, not the endothelial myelomas which are highly radiosensitive and respond very well to radiation.

DR. COLEY, in closing the discussion, stated that the toxins were bacterial rather than chemical in composition.

The susceptibility of the patients to the toxins varies greatly. For this reason he advocates a very small initial dose, not over one-half minim, injected intramuscularly, and increasing by one-half minim, or, if the patient is not very susceptible, by one minim a day, up to the point of producing a reaction of 102° - 104° T. The dosage may be estimated accurately by diluting the toxins with a little freshly boiled water. The temperature is the guide to the dosage. In his early work, Doctor Coley used local injections made directly into the tumor itself, but later on he substituted the intramuscular injections. During the last three or four years, Dr. Bradley L. Coley and he himself have been using intravenous injections in a number of cases, and with, apparently, improved results over the intramuscular. He was not prepared to advocate the intravenous injections as a routine measure. At any rate, the patient's susceptibility should always be tested first by intramuscular injections. For the intravenous it is necessary to begin with a much smaller dose, not over 1/100 minim, diluted with sterile saline solution; if no reaction follows, use 1/90, then 1/80 minim and so on, until the desired reaction has been obtained. The temperature usually rises to 103° - 104° after the first intravenous injection. However, the patient's susceptibility rapidly diminishes, and after six months' treatment Doctor Coley has given as high as 30 minims intravenously.

As to the period of time covered by the treatment, Doctor Coley stated that no definite rules could be laid down that would apply to all cases. The case of Doctor Lilienthal, referred to this evening, with extensive involvement of the spine, ribs and mediastinum associated with complete paraplegia, recovered under only eleven doses of toxins. Doctor Coley believed it better to err on the side of giving the treatment too long rather than stopping too soon. In the Marine Hospital case (first patient presented this evening) the treatment was given by men who had had no previous experience with it. This, and many other cases, he believed, answered the criticism that he was the only one who could get results with the toxins.

POST-OPERATIVE PNEUMOTHORAX EMPYÆMA

HEALING OF EMPYÆMA DESPITE PERSISTENT POST-OPERATIVE PNEUMOTHORAX

DR. DEWITT STETTEN presented a woman, aged thirty-five, who first came under his care January 19, 1929, when she was referred to him by Doctor Otto Hensel and admitted to the Lenox Hill Hospital. She had been critically ill from an influenzal pneumonia for about eleven days. The disease involved the entire right lung and the upper lobe of the left lung. The sputum showed a type 4 pneumococcus. She improved somewhat in an oxygen tent but her fever persisted and definite signs of fluid in the right chest developed, accompanied by slight cyanosis, with temperature 103.8° , pulse 140, and respirations 36. X-ray examination showed an extensive pleural effusion on the right side with the heart displaced to the left and some pneumonic infiltration of the lower portion of the left upper lobe. The right chest was aspirated in the posterior axillary line, eighth intercostal space, and 600 cubic centimetres of purulent serum withdrawn. A culture from the exudate showed a pneumococcus, type 4. Slight improvement followed this aspiration, but on January 23, 1929, the right chest was again punctured and a syringeful of considerably more purulent and thicker fluid than found on the previous aspiration was removed. January 24, 1929, under local anæsthesia, a right thoracotomy was done with resection of four inches of the ninth rib. A large amount of moderately thick, yellowish pus and large masses of yellowish fibrinopurulent material, which were mainly attached to the visceral pleura, were removed—all the exudate lying posterior to the lung. The lung itself was still considerably infiltrated. Two large drainage tubes were inserted for five days and then from January 31 to February 20, 1929, the empyæma cavity was Dakinized.

The convalescence was rather stormy. In spite of the fact that the empyæma wound cleaned up rather rapidly, the patient's temperature remained high, running up to 103.6° , with pulse as high as 130. X-ray examination showed a large pneumothorax with a markedly contracted, rather infiltrated right lung. The heart was displaced to the left. The left lung was relatively clear. It was assumed that the continued temperatures were due to the persistent inflammatory condition in the right lung. The patient further developed a nonsuppurative arthritis of the left hip, which subsided under orthopædic treatment. About one month after operation, the temperatures had finally dropped to normal, the thoracic wound was gradually healing, and the drainage from the sinus had become minimal, in spite of the fact that the pneumothorax, judging from the X-ray examination, had actually increased in size rather than diminished.

April 24, 1929, three months after operation, the patient was discharged from the hospital with a small thoracic fistula from which there was practically no drainage. About a month later the thoracic sinus was almost closed, drainage had ceased, and there were fair resonance, breathing and voice over the entire posterior aspect of the right chest. X-ray examination, however, showed that the right lung was expanded to only about one-half its full size, with a large air cavity making up the balance of the right chest, with thick, fibrous adhesions in the apical portion and, to a lesser degree, at the base. The costophrenic angle was obliterated by greatly thickened pleura. The heart was still slightly displaced to the left. July 5, 1929, the thoracic wound was closed. X-ray showed that the right lung was clearing up and had expanded a little more than at the previous examination, but the large pneumothorax was still present in the upper, outer third of the chest. The heart had come back somewhat to its more normal position.

Since this time, nearly one year and nine months ago, the wound has remained solidly healed, the scar slowly retracting, and the patient has been gradually improving in health and gaining in weight, despite the fact that the pneumothorax has persisted. January 14, 1930, and February 18, 1930, X-ray examinations showed the right lung to be much clearer and a definite accumulation of fluid with a distinct level at the bottom of the pneumothorax cavity. The inner pleural wall has increased considerably in thickness. Presumably the fluid in the cavity was sterile as the patient had no fever, although at this time she complained of pain in her right chest and also of violent attacks of coughing, especially when she lay on her left side, but there was no expectoration. These symptoms, which were probably due to the irritation from the accumulated fluid, disappeared within a few months for seemingly no special reason except, perhaps, because of the spontaneous absorption of the fluid. Since then she has been perfectly well.

Her last examination was made January 6, 1931, by Dr. James Alexander Miller, who reports the condition of her right lung very satisfactory, although the X-ray examination still shows the pneumothorax in the upper, outer third of the chest. The cavity is somewhat smaller than on the previous examination and does not contain the fluid that was noted at that time. The thickening of the pleura on the inner wall has increased slightly and one fibrous band running obliquely across the cavity stands out prominently. The partially expanded right lung is quite well aerated. The fluid has presumably been absorbed, but evidently the rigidity of the walls of the pneumothorax has prevented the expansion of the lung and the absorption of the air.

This case demonstrates that an empyæma cavity can apparently become sterile and heal permanently in spite of a persistent post-operative pneumothorax and is presented because its course is completely at variance with the usual conception of the mechanism involved in the healing of an empyæma cavity. The general impression has always been that an empyæma cavity can only close with expansion of the lung and obliteration of the space between the surface of the lung and the thoracic wall. Where the lung cannot fully expand, due to cicatrization and rigidity of the visceral pleura, it has always been assumed that the residual cavity must fill in by granulation, or, if that is not possible because of its shape or size, then a more or less extensive thoracoplasty to collapse the chest-wall, or a decortication of the lung, or both, were necessary.

During the war, Carrel advocated the Dakinization of the empyæma cavity, freshening of the wound edges, and closure of the thoracic wall by suture when the cultures from the cavity had become sterile. During the influenza epidemic of 1918, the speaker experimented with this procedure at United States Army General Hospital No. 1 at Williamsbridge, New York, and he had an occasional success, the wounds healing by primary union and remaining closed, the air of the pneumothorax being promptly absorbed and the lung expanding. These successes, however, occurred only in a very special type of case—namely, in a streptococcus infection, with a rather acute, recent empyæma, with a relatively thin, seropurulent exudate, and with comparatively slight changes in the pleura. Doctor Stetten's feeling at the time was that the only cases in which one could hope for success were cases where either one or more simple aspirations might have accomplished the same result. He never saw a satisfactory result from this procedure in the pneumococcus infections, with a thick, creamy, purulent exudate, with masses of fibrin, and with any degree of pleuritic infiltration.

POST-OPERATIVE PNEUMOTHORAX EMPYÆMA

DR. HERMANN FISCHER said that the case of persistent pneumothorax presented by Doctor Stetten was similar to a case which had been under his observation for over two years. The patient, a young girl of seventeen years, at the ages of four and eight had pneumonia and since that time has always been coughing more or less with a productive yellow sputum. She also had influenza and has always been subject to colds and was always, in delicate health. Four weeks ago the patient again caught cold and complained of pain over the left chest; the pain was very severe and she felt very weak. On this day she came to the Lenox Hill Dispensary and was sent to the X-ray department for examination. The röntgen examination revealed well-aërated apices with no pathologic markings suspicious of changes due to pulmonary tuberculosis. The lower lung fields, however, contain very heavy lung markings with the greatest present at the left base just above the diaphragm. Here the appearance would suggest changes due to bronchiectasis. On the right side, the changes are not characteristic and the marked thickening is not visible. Cardiac and diaphragmatic outlines are normal.

After the röntgen examination she went downtown and, while shopping, suddenly experienced a sharp pain in her left chest, had considerable dyspnoea and a fainting spell with nausea. She was brought home and was treated there for a pneumonia. She was sick at home for a month and then was brought to the Lenox Hill Hospital. On admission a diagnosis was made of a pyo-pneumothorax, interstitial suppurative pneumonia with abscess formation superimposed on bronchiectasis.

On the same day, 1100 cubic centimetres of very foul-smelling fluid were withdrawn with the Potain-aspirator. On the following day, December 6, 1928, an additional amount of 375 cubic centimetres of fluid of the same character was aspirated.

December 8, 1931, under novocaine anæsthesia, a portion of the ninth rib in the posterior axillary line was resected. When the pleura was opened a very large amount of very foul pus was evacuated. Drainage by means of a large rubber tube was established.

After the operation the patient improved slowly but steadily. By January 15, drainage had ceased. January 22, 1929, she was discharged from the hospital with a completely closed chest.

The X-ray examination showed that there is incomplete expansion of lung; in the outer and middle thirds of the chest appears to be an area of pneumothorax.

The patient appeared every three months for re-examination at the follow-up clinic. She has gained about thirty pounds in weight and looks rosy and healthy. The large amount of sputum—150-250 cubic centimetres and more during the day—which she had formerly has diminished to 10-15 cubic centimetres. Her appetite is good and she attends school regularly.

An X-ray examination on June 8, 1930, revealed the following condition. There is a large area of pneumothorax in the outer half and mid-left chest. No fluid is visible. The left lung is about half expanded and fairly well aërated. The pleural boundary of the pneumothorax is moderately thickened. Heart and trachea are not displaced.

Doctor Fischer observed that cases in which large empyæma cavities heal with a persistent pneumothorax must certainly be rare otherwise they would appear more often in the surgical literature. In his case the persistence of the pneumothorax with the compressed lung has been of undoubted benefit

to the patient so far, inasmuch as it has helped to obliterate the existing bronchiectatic cavities.

DR. ALEXIS V. MOSCHCOWITZ stated that he had seen a number of cases of empyæma which healed and which remained healed with a pneumothorax. He originally made this observation during his service on the Empyæma Commission during the war and he had explained in previous articles the definite healing of the empyæma cavity by absorption and rarefaction of the air within the pneumothorax and subsequent expansion of the lung.

DR. CARL EGGERS said that ordinarily one should not consider an empyæma healed until the cavity has been completely obliterated. The lung has to be re-expanded and form contact with the parietal pleura. Usually this takes place as healing progresses. Sterilization of the cavity and obliteration go hand in hand.

Occasionally, however, one finds a patient in whom the outer opening closes before the lung has fully expanded. If in such a case infection is still harbored within, recurrence will develop, but if the cavity is superficially sterile the patient may get well that way. Doctor Stetten's patient evidently belongs to this group.

Great interest attaches to the reason for the nonexpansion of the lung in these cases. A lung expands as soon as an exudate has been evacuated unless dense adhesions bind it down. Even in pneumothorax treatment of pulmonary tuberculosis constant refills are necessary to keep the lung compressed. What, then, is the difference between the usual empyæma cases and those in whom the lung fails to re-expand? One must differentiate between lung compression and lung collapse. In the ordinary empyæma and in artificial pneumothorax pressure is made on a lung with an intact covering. In such a lung the normal mechanism tending to expansion is operative. If, however, a perforation through the visceral pleura is present, such as one finds as the result of perforation of a lung abscess, the lung collapses and the normal respiratory mechanism for that lung is changed. In such a collapsed lung fibrous tissue changes may take place, interfering with normal re-expansion even if the perforation eventually closes. The usual treatment required in this type of a case is some form of thoracoplasty.

Doctor Eggers then showed slides of a case in which healing had also taken place in the presence of a large cavity. The patient was admitted seven years ago with an acute pyo-pneumothorax. There was considerable tension within the chest and with the patient lying on the side a fluid level was visible. After prolonged drainage and treatment by the Carrel-Dakin method, the cavity became sterile but the lung failed to re-expand. Healing took place, nevertheless, and the patient has remained well.

DR. EDWIN BEER agreed with Doctor Moschcowitz as to the two methods of healing empyæmata. He was under the impression that healing took place with the formation of pneumothorax, as illustrated by Doctor Stetten's case,

METHODS OF TREATMENT IN OPERABLE MAMMARY CARCINOMA

more frequently than is generally appreciated. A little over a year ago, he had shown a case very much like Doctor Stetten's in which the chest-wall was closed after he had resected part of the lung for persistent bronchial fistulæ associated with empyæma. Control X-rays made with regularity after the chest was closed demonstrated a pneumothorax, with a small collection of fluid at the lower end. This fluid gradually absorbed, as did the air, so that when the child was presented there was only a small circular air pocket at the site of the previous empyæma cavity. Recently, much to his surprise, the process which had apparently been so well controlled again produced empyæma, and the child came in with an empyæma in the same site as that of three years before. This bears out what Doctor Eggers says as to the permanent cure of these cases.

THE RESULTS OF TREATMENT OF OPERABLE MAMMARY CARCINOMA

DR. FRANK E. ADAIR read a paper with the above title.

DR. GEORGE H. SEMKEN said that he did not feel wholly competent to judge the value of irradiation in the primary treatment of operable cases of cancer of the breast, for he had not seen the good results, and the cases so treated that have come under his observation had all been failures. In order to give a true picture of this form of treatment, the reports should not stop at emphasizing the apparently favorable effects, but they should also state frankly what happened in the larger group of cases (roughly two-thirds of the total number in Doctor Adair's series), in which unfavorable incidents occurred or in which the treatment proved unsuccessful. How many of these failures were in early, very favorable cases that would probably have been cured by operation; and how many patients were painfully and even seriously injured by the irradiation? Some patients of this class, that have come under his observation, showed extensive irradiation damage; and they had an intensity of suffering from the treatment far worse than is seen with advanced cancers that had either had no treatment whatever or had recurred after operation.

The mechanism of the effect of irradiation in the treatment of cancer is still an unsettled question despite the years of intensive study of this subject; but at this time, it should be generally recognized and admitted that irradiation with X-rays or radium has no specifically selective action upon the cancer cell as contrasted with the normal tissues. How much of the effect is due to direct primary injury to the cells; and how much to a reactive process in the surrounding tissues, which results in an encapsulating fibrosis about the tumor? Wood has shown that five erythema doses are required to kill all the cancer cells. Regaud, whose conservative opinions inspire confidence, believes the result is produced by both a primary injury to the cell and an associated reactive process in the surrounding tissues. Asherson, however, (recently quoted in the *British Journal of Radiology*), concludes from the study of a large number of cases that the sole therapeutic action of radium lies in its being a "stimulator and producer" of fibrous tissue. It is certain

that there is a great variation in the susceptibility of different cancers to irradiation, from the anaplastic cell types to the more highly differentiated tumors; and in those that approach the normal structures closely, clinically and histologically, it would be illogical to expect a considerable difference between the tumor and the normal tissue in the reaction to irradiation. So it is not surprising to note that some cancers are wholly resistant from the beginning and that in others the first favorable effect of irradiation upon the tumor is often followed, sooner or later, by a progressive cancer growth which is wholly resistant to further irradiation. Corollary to this is the observation that cancer tissue that persists after irradiation may grow and infiltrate less rapidly than untreated cancers or those recurrent after operation. This is less a consequence of destructive changes in the cancer cells than of the fibrosis and the sclerosed blood-vessels in the field in which they lie, *i.e.*, a simple expression of poor nutrition. The two primary cases presented by Doctor Adair illustrate both of these points very well. Though apparently well clinically, these patients still have active cancer cells in the breast, as shown in the biopsy examination, and they have not been cured; but the cancer foci have given no other evidence of their presence for six years, and in this unfavorable soil the apparent latency may continue.

The diagnosis of cancer of the breast from clinical findings alone without microscopic examination may be fairly dependable in typical cases; but experience and laboratory records have shown many errors. L. Duncan Bulkley, in his book "Cancer of the Breast," collected 250 cases from his private practice, in nearly all of which the diagnosis of cancer had been made by "competent physicians and surgeons"; but many of the tumors had disappeared spontaneously under the treatment by diet alone, and obviously these were not cancers. For statistical purposes, therefore, purely clinical diagnoses of breast cancer have a doubtful value, and it is misleading to contrast, in table form, the end-results of the irradiation treatment of such cases with the results of radical surgery in histologically proven cancer cases. He was in full agreement with Doctor Adair, however, in considering biopsy a dangerous procedure in breast cancer.

In tabulating the end-results of the radical operation for cancer of the breast, it is considered a surgical failure if the patient has died from cancer. In fairness to surgery, it should be noted whether the cancer death was caused by a recurrence, local or regional, or by a distant metastasis without local or regional recurrence. Comparative tables for irradiation *versus* surgical treatment, then, should deal primarily with such local or regional cancer persistence alone. Following a comprehensive operation, recurrences at the site of the breast or in the regional lymph-nodes are infrequent; and the late fatalities are usually due to metastases chiefly in the lungs or the bones, and to a less extent, in the liver and other organs. The underlying histologic reason for this, apart from the lymphatic transit to the blood-stream, lies in the presence of invading cancer cells in the small veins; and this constitutes a weak spot in the treatment of this disease. It has been repeatedly recorded in the

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pathologists' reports. M. B. Schmidt, Tyzzer, and Wood and Knox have clearly shown that these plugs of cancer cells become dislodged by handling and massage and are carried to the lungs. The emboli become inclosed in clots, and, while many cells do not survive, others grow through the clots and some of these may find lodgment upon the walls of the small veins of the lung to form invading metastases. Small cancer cells pass through the capillaries and are disseminated by the arterial circulation. Two important clinical factors thus become evident—one, the danger of delay which allows time for such metastases to occur; the other, the danger of handling the breast if cancer is present—handling by the patient, accidental pressures, the use of massage often upon inexcusable medical advice, and injudicious examinations by physicians. Most physicians do not know how to examine the breast. It is unfortunate, also, that cancerous processes are indurated, and that this fact is so strongly emphasized for the diagnosis, for it is probable that many distant metastases have been produced by firm palpation to determine the consistency of the tumor.

The clinical experiences following operations for cancer of the breast, in general, are not a true index of the value of radical surgery; for many of those who operate upon these patients are not competent to do this work. The fundamental principles underlying the radical operation are well understood but they are not universally applied.

Efficiency in doing comprehensive cancer surgery is not a personal quality limited to a few, but it is mainly a matter of the proper angle of view of cancer cases, supplemented by an average surgical training and the conscientious acceptance of a serious responsibility. It has been gratifying to observe, among internes and assistants, the rapid development of a sharp cancer sense and a dependable competence in a very short period of time. Cancer of the breast will probably remain a surgical disease in its operable stages; and irradiation will remain indispensable for unfavorable and inoperable cases. A candid critical judgment will be helpful to both.

STATED MEETING HELD APRIL 8, 1931

The Vice-president, DR. JOHN DOUGLAS, in the Chair

CARCINOMA OF RECTUM

DR. MORRIS KELLOGG SMITH presented a man who entered St. Luke's Hospital in August, 1930. He had been passing blood by rectum for the previous six months and for three or four months had been having five to fifteen movements a day. He had lost twelve pounds. He was a thin, rather sickly appearing man of twenty-eight. On rectal examination numerous small polyps were felt and three to four inches above the anus an ulcerated lesion the malignant nature of which was confirmed by biopsy. The patient deferred operation until October at which time a combined abdomino-perineal excision of the terminal 35 centimetres of bowel was done. The tumor measured 7 by 5 centimetres. The entire mucosa of the segment was studded with polypoid tumors (Fig. 1). The pathologic diagnosis was adenocarcinoma.

The patient, following operation, continued a tendency to looseness of the bowels which has been helped by including 2 or 3 bananas a day in his diet.

Doctor Smith presented also a woman, sixty years of age, who was admitted to St. Luke's Hospital in February, 1920. The chief complaint was rectal bleeding. For four months there had been increasing constipation, weakness and loss of appetite; for the past month pain and bleeding from supposed hemorrhoids. Just within the anal sphincter on the posterior and lateral wall there was an ulcerating tumor about $2\frac{1}{2}$ centimetres in diameter. It was movable. An operation was planned more as a palliative procedure than with the hope of cure. A left inguinal colostomy and a perineal excision of the rectum with suture of the amputated end of the bowel to the perineal skin was carried out. The pathologic report states that the growth was continuous with the mucocutaneous margin, that it occupied almost the entire length of the section there being less than 1 centimetre of normal mucosa above, and that it involved the entire muscle coat. The diagnosis was carcinoma of the rectum, squamous-cell type. The patient made an uneventful convalescence and was discharged on the twenty-third day.



FIG. 1.—Polyposis of rectum and sigmoid with carcinomatous ulcer.

She has remained under observation in the follow-up clinic since and up to date, more than eleven years, there has been no recurrence found.

The case demonstrates that in selected cases when the radical operation is contraindicated a more conservative procedure may be well worth while.

DR. FRANK S. MATHEWS recalled a case of carcinoma involving the anal sphincter which has remained well for six years, and which was treated somewhat like Doctor Smith's case. The operation was entirely through the perineum. The proximal bowel was sutured to the skin but at a later time, because of the absence of sphincter, a very extensive prolapse of rectum occurred which requires a T-bandage for its partial control. The patient declines any suggestion of operative relief.

DR. JOHN DOUGLAS said that he had had two cases of squamous-cell epithelioma of the rectum near the anal margin. The first one was operated on more than two years ago by a complete local excision of the tumor and microscopic examination revealed carcinoma. More radical operation was advised and refused. The patient has remained well ever since with merely this local excision and radiotherapy. The other patient, an old woman, was

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operated on a year and a half ago for a small epithelioma of the same region and she has remained well ever since, following a similar procedure. It is a question whether these squamous-cell epitheliomata of the anal margin are as highly malignant as the adeno-carcinoma higher up in the rectal wall although they are considered more so. Both of these patients show no sign of the disease at present although the operation in each case consisted merely of what might be called a radical biopsy.

FISTULA OF SIGMOID; COLOSTOMY; CLOSURE OF COLOSTOMY AFTER FIVE YEARS

DR. MORRIS K. SMITH presented a woman who entered St. Luke's Hospital in the summer of 1921. Three years before, she had been operated on at another hospital, both tubes and part of an ovary having been removed. Since then there had been a fistula opening into the scar. The amount of drainage was small, partly purulent, partly faecal. He made an attempt to close the fistula following the track down behind the uterus to the lower sigmoid and excising it. The result was failure, and she entered the hospital six months later for a second attempt. The repair of the bowel at this operation rapidly broke down, there was evidently extensive suppuration in the pelvis, faeces drained largely through the wound, and the patient gradually went downhill until she was much emaciated and it became evident that only radical measures could save her. A colostomy of a temporary type was therefore done in the descending colon. This was in June, 1922, four months after the second attempt at cure of the fistula. Improvement was immediate and striking. She left the hospital in August.

Two years later, the old fistula was almost closed but a hernia was developing in the scar. In the meantime the patient had been gaining weight and taking care of her family.

In April, 1927, five years after the colostomy was made, she entered the hospital to have it closed. For the past two years the bowels had been moving largely per rectum; the hernia in the median incision was larger; the old fistulous track seemed dry. Closure was accomplished without difficulty and she was discharged on the fifteenth day. A little over a year later, in July, 1928, the hernia through the old median incision had closed.

Doctor Smith presented this patient to illustrate: (1) The life-saving feature of colostomy in the presence of faecal drainage and suppuration, (2) The gradual spontaneous obliteration of the sigmoid fistula following colostomy, (3) Closure of colostomy after five years.

BRANCHIOGENIC ADENOMA OF THE NECK

DR. JOHN M. HANFORD presented a man, sixty-one years of age, who applied at the Presbyterian Hospital in August, 1930, because of a swelling in the left side of the neck of about two years' duration. It had been symptomless except for gradual increase in size, and for occasional twinges of pain lately. The past history was essentially negative except for frequent colds with post-nasal discharge. He had a severe cold two years ago. Polyps were removed from the nose a year ago. During the past year he has had dizziness, dyspnoea and palpitation on exertion, but no swelling of ankles. There is no history of venereal disease.

In the left side of the neck, behind the angle of the jaw and below the ear, over the upper part of the sternomastoid muscle, there is an ovoid mass about 4 by 5 centimetres in size, moderately prominent, smooth in outline,

freely movable, not attached to the skin, but connected with underlying structures. It feels elastic or cystic, not tender. No palpable nodes are present in the neck, except two in the right submaxillary region. The right lobe of the thyroid is enlarged, and there is a separate nodule corresponding to the isthmus.

Under intranasal ether, operative removal of the mass in the left side of the neck was made August 15, 1930. There was found a rounded, lobulated tumor some 4 centimetres in diameter and about 2 centimetres thick. It was encapsulated and lobulated. It felt soft and the cut surface had a yellowish mottled appearance almost like liquefaction-necrosis. As the upper anterior portion of the tumor was dissected, two or three drops of what looked like pus appeared: but no abscess cavity was found; this liquefaction being due to degeneration of epithelial cells often seen in neoplasm of branchiogenic origin.

The report on the tissue from the surgical pathology laboratory was as follows:

A composite tumor of the parotid consists of a tumor mass measuring 4 by 3.5 centimetres. It is entirely covered by a thin connective tissue capsule except where it has been cut open. It is roughly oval and its surface shows a few small lobulations. It is firm and resilient to palpation. Upon section the cut surface is muddy gray and contains several somewhat yellowish areas scattered throughout. At one margin there are numerous ecchymoses. The cut surface is not extremely hard. No mucinous areas can be seen. Microscopic sections show an unusual picture. The bulk of the mass is composed of lymphoid tissue containing large germinal centres. Running throughout all the lymphoid tissue there are numerous large alveolar spaces lined by three or four layers of pale, cuboidal or polyhedral epithelial cells that are very uniform in size, shape, and staining qualities and which show no mitotic figures. Their cytoplasm is very finely granular, and they have rounded or oval vesicular nuclei and often contain distinct nucleoli. In the cells immediately bordering the lumen many of the nuclei tend to be hyperchromatic. Within the alveoli there are large masses of granular debris, desquamated epithelial cells and numerous cholesterol crystals. The epithelial cells have clear-cut basement membranes, and in no place do the cells appear to be actually invading or infiltrating the lymphoid tissue. The shapes of the alveoli are not markedly irregular but are rounded, oval, or dumb-bell in shape. In some areas there are papillary projections of this same epithelium extending into the lumen and in these the epithelium rests upon delicate connective tissue stalks or are broader and more club-like and their bulk is made up of lymphoid tissue and their centres frequently contain germinal centres. A section of the lymph-gland removed from the outer surface of the tumor mass shows nothing unusual. A small fragment of parotid salivary tissue is attached to one margin. This is an extremely rare tumor and most closely resembles the branchiogenic adenomas described by Lubarsch. These are due to embryologic rests resulting from a pinching-off of portions of the early oral epithelium and mesenchyme. This does not have the appearance of a malignant tumor or of a metastasis from a malignant tumor.

When seen two and seven months after operation the neck was apparently cured of the original disease. No enlarged nodes were felt. There was slight diffuse enlargement of the thyroid gland.

DOCTOR HANFORD presented also a man, forty-five years of age, who first came to the Presbyterian Hospital in January, 1931, with a large swelling in the left side of the neck, but otherwise well and doing his usual work. Five years previously he had first noticed a small lump in the same side of the neck—the size of a marble. It felt hard and movable. It had gradually increased to the size of a goose egg. About three years ago the mass was removed at an out-of-town hospital. Tonsillectomy was done at the same

BRANCHIOGENIC ADENOMA OF THE NECK

time. The report received from this hospital is that the main mass was found in the submaxillary region, discrete, smooth, freely movable. One large gland and several smaller glands were removed from the left side of the neck, and buried tonsils were removed. He evidently recovered well from the operation, the wound healing quickly. The report from the specimen removed from the neck at that time states the histologic findings to have been interpreted as carcinoma of the glands of the neck. A study of a slide has been made, loaned to us from this hospital.

The microscopic section shows numerous cyst-like cavities lined by an intermediate type of epithelium which in some areas shows a tendency to become squamous. In other areas it is more columnar. In addition to the lining of the cavities the epithelium projects in papillary forms with central stalks of connective tissue or containing thicker masses of lymphoid tissue. In one or two areas the epithelium shows extreme hypertrophy and projects into cavities in large masses. In these areas the cells are small, closely packed, contain a small amount of cytoplasm and contain rounded or oval hyperchromatic nuclei. Occasional mitoses are seen. In these areas of hyperplasia tiny capillaries are found among the epithelial cells. Where the lining epithelium is thinner there is a slight variation in size and staining qualities of some of the cells. Several small areas of degeneration are found among the masses of epithelial cells but there are no definite epithelial pearls. Mitoses occur but are not frequent. In the accompanying lymphoid tissue only occasional germinal centres are seen. The thickness of the epithelium lining the cavities varies from three or four cells to very many cells. Within the cavities there is seen a pinkish-staining, homogeneous material containing a few red cells, round cells, polymorphonuclear leucocytes and apparently some degenerated or desquamated epithelial cells. The remainder of the specimen is composed of connective tissue containing various amounts of lymphoid tissue and small blood-vessels.

Lubarsch calls these tumors branchiogenic adenomas. Terrier and Lecene consider them tonsillar branchial cysts. It is a question whether the tumors actually become malignant or not.

This slide was not thought by our surgical pathologists to show carcinoma.

A complete ear-nose-throat examination revealed no point of origin for the neck disease. There is a right chronic otitis media.

On March 9, 1931, he was operated on at the Presbyterian Hospital to remove two nodes from the lower part of the neck and some tissue from the middle of the main mass. The two small wounds healed readily.

Dr. F. M. Smith reports the microscopy as follows: sections of the tissue removed from the main tumor mass show large wavy or folded masses of epithelial tumor cells. These masses coalesce but are partially separated from each other by irregular connective tissue bands. Clefts are sometimes seen within the masses of tumor cells and in many areas the cells tend to have an arrangement around these clefts but this is not constant. In other areas there are large defects in the tumor cell masses filled with a granular debris and in one or two areas this is stained reddish with the trichome stain which shows that it contains some keratin. Numerous round cells are scattered throughout but are found chiefly in the connective tissue strands between tumor-cell masses. For the most part the tumor cells are somewhat ovoid in shape, containing vesicular nuclei that fill nearly the whole cell. In other areas the cells are smaller, more elongated and have thin hyperchromatic nuclei. Mitotic figures are extremely numerous and average about two or three per high power field. Sections of the two lymph-glands removed below the tumor mass show only a small amount of normal lymphoid tissue preserved along one margin of the smaller. The remainder of the lymph-glands is filled with the same arrangement of tumor cells described in the main mass. Larger bands of fibrous tissue separate the tumor masses in some areas than in the main mass. This would appear to be definitely a metastasis into the cervical lymph-glands.

This is rather a poorly differentiated squamous-cell epithelioma, apparently branchiogenic in origin and differs from the biopsy sections removed several years ago in that it contains at the present time almost entirely epithelial elements rather than epithelial and lymphoid elements as seen previously. It seems to be a rather slow-growing tumor but the metastasis in the lymph-glands would indicate that the prognosis was not good.

This is an exceptionally rare sequel of tumors of branchiogenic origin and to predict the rapidity of its course would be extremely hazardous.

Diagnosis.—Squamous-cell epithelioma (branchiogenic type) of lateral neck region with metastases to cervical lymph-glands.

This patient was presented because of the unusual finding of branchiogenic adenoma which apparently gave rise to a squamous-cell epithelioma—rarely seen in branchiogenic tissue.

It is important, as a general rule, to remove early all neck tumors no matter how innocent in appearance.

TUBERCULOSIS OF THE CERVICAL AND AXILLARY LYMPH-NODES WITH ERYTHEMA INDURATUM OF THE LEGS

DR. JOHN M. HANFORD presented a young woman, eighteen years of age, who first had enlarged nodes in the neck at the age of eight years. She came in March, 1924, at the age of eleven, to the Presbyterian Hospital with numerous lesions in the left side of the neck—an abscess, a sinus, and several firm nodes, evidently tuberculous. The lungs were considered clear except for enlarged hylus regions shown in the chest X-rays. There was a slight anæmia. The tonsils and adenoids were enlarged.

She was treated first by excision of the disease in the upper part of the neck. The tissue proved to be tuberculous. Nine days later the tonsils were removed and showed on tissue examination only chronic tonsillitis. Five days later she was discharged from the ward in good general condition, but with enlarged supraclavicular nodes, an unhealed wound in the left side of the neck, and enlarged left axillary nodes recently noticed.

At the age of fifteen, after seven years of continuous lymph-node tuberculosis, there was a new flare of disease in the neck, with erythema induratum of the tuberculous (Bazin's disease, or papulo-necrotic tuberculide) type, the typical lesions of which appeared on the legs. Five months later, five years after our first treatment, she was in good condition, but still showed disease in the right side of the neck, and the leg lesions, which now were troublesome.

By last August the legs were much better, and the neck and axilla were apparently healed. At the end of a summer of sunshine and rest, and good hygiene, she was practically well, only to suffer severe reactivity in the right neck and in the legs. In December last she was readmitted to the hospital. After improving her general resistance a radical right neck dissection and removal of a caseous left-node was made under avertin and intra-nasal ether anæsthesia. Enlarged nodes, a sinus, and a cold abscess were excised, and showed tuberculosis in a tissue examination. A biopsy was made from one of the leg ulcers on the lower calf, and the dermatologic laboratory reported their histologic diagnosis to be papulo-necrotic tuberculide. The blood Wassermann was negative.

She was again operated on in early February, 1931, to remove the last vestige of active apparent lymph-node disease. This was in the right axilla from which tuberculous nodes were cleaned out February 6.

In the follow-up clinic, two weeks ago, the general condition was excel-

PULSATING EXOPHTHALMOS

lent; there were two small sinuses in the right side of the neck at the drain sites; and only two minute superficial leg ulcers.

This young woman was presented as a case of tuberculous erythema induratum of the legs associated with lymph-node tuberculosis—a clinical picture occasionally seen, and only in young women. The relationship between the disease in the nodes and in the legs is unknown. It was at first thought the leg lesions were due only to the toxins of tuberculosis but tubercle bacilli have been demonstrated in the lesions and now they are considered true infections. Krysolgon injections are favorably viewed in the treatment of the leg lesions. It appears logical, in addition, or, rather as the main factor in treatment, to eradicate the tuberculous lymph-node disease with which the leg lesions are almost invariably associated, and to which they are almost certainly attributable.

The fundamental treatment for the legs is radical, surgical removal of the diseased nodes in suitable subjects, unless such climatic conditions are available as those of Switzerland and Arizona. General care and careful dressings go without saying.

PULSATING EXOPHTHALMOS. HEMIPLEGIA FOLLOWING OCCLUSION OF THE INTERNAL CAROTID ARTERY

DR. JOHN M. HANFORD presented a man, fifty-three years old, who, in July, 1930, fell and struck his head, and suffered with vomiting and headache for a day or so. He soon felt severe pain in the left ear, and prominence of the left eye which turned inward. He then spent about two weeks in a hospital, a report from which states that the blood Wassermann was strongly positive, the spinal fluid normal, and the diagnosis: some cerebral lesion; syphilis; paralysis of the left rectus muscle of the eye.

After this he was sent to an eye specialist and then to a neurologist. By this time, he says, he had lost nearly all his vision in the left eye.

The right eye became prominent about three weeks after the accident, but never as much so as the left eye. Both eyes became very red and congested. Some little time after the accident he became conscious of a pulsating noise in his head, especially marked in the left ear. Since the accident he has had no sense of smell.

In August, he spent four weeks in another hospital with twenty intramuscular injections. There an operation was advised, which advice culminated in his examination by Dr. John M. Wheeler, who made the diagnosis of pulsating exophthalmos caused by an arterio-venous aneurism in the cavernous sinus from injury, probably to the body of the sphenoid bone.

The past history is of little consequence except for a chancre thirty-three years ago with treatment for a short time in London, England. He had been a sergeant in the British army, a vigorous, healthy man.

In November, 1930, he was admitted to the Presbyterian Hospital. His general condition was good, but he had marked prominence of the eyes, extreme congestion of the conjunctival, and scleral vessels, and subconjunctival ecchymoses. The left eye looked much the worse and did not rotate outward.

In the right eye, vision was 20/30 and in the left 20/50. Exophthalmometric readings showed the right, 30.5—the left, 32. Measurements of interpalpebral fissures showed the right, 11.5, the left, 12. Tension was greater in the left eye. The lids were markedly oedematous. All signs were present of marked bilateral exophthalmos. Pupils reacted to light and accommodation. The bruit was heard loudest over the left globe. Faint

pulsation of the left globe was felt on deep pressure—no visible pulsation. The blood pressure was 170/100, the pulse about 70. There have not been any signs of cerebrospinal lues. The patient has been said to be hypersensitive to Salvarsan. The general physical examination was essentially normal. A few hyalin casts were found in the urine; the blood Wassermann was strongly positive. Röntgen-ray studies of the skull showed nothing abnormal, both in November, 1930, and in March, 1931. It was assumed there was a fracture of the base, not detected.

Digital compression of the left common carotid artery stopped the subjective and objective bruit. If continued for two minutes he felt numbness and weakness in the right extremities.

The treatment, started in late November, consisted mainly of digital compression of the left common carotid artery, followed December 12 by partial occlusion of the left internal carotid artery. The compression was made three or four times daily, mostly by the patient, though supervised by a nurse. The period was slowly increased from two to fifteen minutes at a time.

The occlusion was done under regional anaesthesia. A Matas-Allen aluminum band was applied to the artery so that the bruit was barely heard over the left globe. The patient began to improve in every way. The next day no bruit at all was detected. He felt better than at any time since the accident. The eyes greatly improved in every way. He was kept quiet in bed. On the ninth day after the operation he developed within a few hours (the details are not known) a complete hemiplegia affecting the right side and involving the speech centre so that he was completely aphasic.

Various types of physical therapy were begun soon after this accident and he has recovered enough to walk and to make himself understood.

He left the hospital January 24 with no subjective or objective bruit, no pulsation of the globes, no retinal hæmorrhages, slight vascular congestion, and with exophthalmometric readings of 24.5 in the right eye and 25.5 in the left.

By the middle of February he began to detect the bruit starting in the ear, and it became audible with the stethoscope, loudest over the left globe, and also quite loud in the neck, just above the recent operation scar. All of the pre-operative eye findings returned. Blood pressure was 175/100. It was evident that the aneurism had recurred and that its course would be progressively worse. He was readmitted to the hospital February 26.

It had been planned at the start to follow the partial occlusion by a complete occlusion of the artery at a second operation, and, at the second time, to ligate the left internal jugular vein. The partial occlusion evidently became complete spontaneously and caused the hemiplegia from softening of the left cerebral hemisphere due to inadequate blood supply. It was decided, therefore, at the second operation, to ligate the vein, which was done March 23. The internal carotid artery was found completely occluded. No cause for the bruit heard in the neck was found. The vein was smaller rather than larger than usual.

Since the vein ligation, the bruit is less loud but still present, loudest over the left globe and in the left side of the neck. But the bruit cannot be eliminated by digital compression anywhere—not even of the right common carotid artery. It is doubtful, therefore, whether a right carotid occlusion would be helpful even if it were safe.

He now presents a right hemiplegia with motor aphasia, with partial recovery, a persisting arterio-venous communication with symptoms improved

DELAYED AND NON-UNION FRACTURES

over what they were before the arterial occlusion, latent (?) tertiary syphilis, and hypertension.

It is felt that intensive antiluetic treatment is just as likely to do harm as good. The course of the aneurism will probably be increasingly worse, yet one's hands seem to be tied in attempting any method of further curative treatment. The great lesson we have learned from this case, is the importance of assuring a *partial* occlusion which will remain *partial* until a favorable time comes for increasing or for completing the occlusion. The Matas-Allen band (No. 20 gauge, aluminum) is the best instrument for this purpose. In this patient, it was compressed too much to restrict the effect to a partial occlusion.

DR. DEWITT STETTEN remarked that this case illustrated the danger of ligation of the internal carotid artery. It seems to be a common idea among ophthalmologists that this is the operation of choice in pulsating exophthalmos and that it is a very simple and safe procedure. The speaker recalled discussing the question some years ago with an ophthalmologist regarding a woman who, after an automobile accident, had developed a pulsating exophthalmos. She was about sixty years old and a diabetic, but his friend urged ligation of the internal carotid artery as he considered it was not a serious operation, and referred to some extremely favorable statistics of his own. Doctor Stetten had refused to perform the operation in this case because he felt it was too dangerous. The incident impressed him with the casual way in which the ophthalmologists have advised ligation of the internal carotid artery, as though it were a minor procedure fraught with no danger at all. The feeling among surgeons is that ligation of the internal carotid artery is an extremely serious operation after middle life, that it is very liable to be followed by a hemiplegia, even if the occlusion is a gradual one as Doctor Hanford has shown, and that it can often result fatally.

DOCTOR HANFORD rejoined that statistics vary on the danger of ligation of the common or internal carotid artery; it depends on the condition of the arteries. In this case it was planned to do a partial occlusion and at a selected time to increase it; but the mistake was made of clamping down the metal band too tightly so that the occlusion became complete in one stage. The lesson to be learned from this case is that if one is to carry out the plan of partial occlusion, one should be certain it is only partial occlusion, for later on complete occlusion may be safely done or it may prove to be unnecessary.

DELAYED AND NON-UNION OF FRACTURES

DR. CLAY RAY MURRAY presented the following cases:

CASE I.—Male, twenty-one years, admitted to the Fracture Service of the Presbyterian Hospital March 22, 1930. In May, 1929, he had a compound fracture of both bones of the leg at junction of middle and lower thirds of leg. Was treated by primary débridement and pin traction, with Carrel-Dakin wound treatment in another hospital. He was in the hospital twenty-one weeks. Since then has had persistent sinus, which has been undergoing dressings, but has been able to get about on the leg. At intervals

the fracture site becomes painful and tender and remains so for a while, to subside on rest.

Film of the right lower leg in stereoscopic views reveals the presence of an old fracture at the junction of the middle and lower thirds of the tibia and fibula. There has been a considerable amount of bone production about the fracture line of the tibia, but nothing is present to suggest bone union. The fracture line is still sharply outlined. It is possible there is fibrous union but one is unable to see it on the films. There is slight overriding of the fragments of the fibula and no attempt at callus formation about the ends of the fragments. The bone about the ankle shows marked decalcification apparently due to disuse. There was slight angulation at the fracture site, very slight mobility, considerable tenderness, and pain on the demonstration of the slight mobility.

March 24, 1930, Doctor Bull exposed the site of fracture by incision, 15 centimetres. The tibia was enlarged, twice its normal diameter, mainly anteromedially. The line of fracture was clearly demonstrated and the union seemed to be fibrous. The sinus track on skin led to a small abscess containing a split-pea-sized sequestrum on anterior cortex at the anterior edge of the bone. The infected bone was apparently confined to an area measuring 3 centimetres in diameter. Tissue in medullary cavity appeared normal. The overlying skin was excised and the bone removed by chisel to leave an anteromedial and posterior shell. The resulting saucer measured 3.5 centimeters in depth and width and 12 centimetres in its greatest length. The cavity was packed with Mikulicz tampon of vaseline gauze, and a plaster-of-Paris circular splint applied to include lower third of thigh and foot.

The next day, through a window cut in this plaster exposing the bone cavity, the vaseline gauze was removed, the wound surface made to bleed throughout by rubbing with gauze, and the blood-filled cavity packed with sterile-powdered chemically pure calcium carbonate and triple calcium phosphate in proportions of one and three. The powder was well mixed with the blood in the cavity, and filled the whole cavity to the skin surface. It was covered by vaseline gauze and the window replaced in the plaster.

The cavity was inspected two weeks after placing of the calcium, and note made that the cavity was filled to half its depth with firm granulation tissue containing numerous areas of whitish discoloration due to presence of calcium in the tissue.

A new plaster casing was applied. This was removed on May 3, five and a half weeks after placing calcium, and the wound was found completely filled with the same type of tissue, which was actually exuberant above the skin level. Adhesive strapping was applied to aid in the epithelialization of the granulating area. On May 7 he was discharged with clinically solid union, and with no splints, six weeks after placing the calcium. X-ray one month later showed firm bony union through the shaft of the tibia. The picture shows no evidence of the cavity that was created at operation. Subsequently the skin scar required some surgical attention, and there are some minor static troubles due to a slight angulation. Twenty weeks after the original operation the patient was driving a car without any difficulty. At nine weeks the patient was walking on a leg brace; at fourteen weeks without brace except for protection in street. At sixteen weeks he was without brace support. Bony union was present at six weeks and cure of the osteomyelitis and obliteration of the operative defect 12 by 3.5 by 3.5 centimetres was present at twelve weeks, despite the fact that the operative procedure for the cure of a low-grade osteomyelitis and non-union embodied the removal of a great deal of bone as the essential procedure.

CASE II.—Male, aged twenty-six years, admitted to the Fracture Service of Presbyterian Hospital, October 20, 1930; eight weeks before admission sustained a compound fracture, with comminution in the mid-portion of the tibia. This was reduced under anæsthesia at another hospital and placed in circular plaster, with a window through which dressings were done for the compounding wound. Has been on crutches with slight weight-bearing on plaster since.

DELAYED AND NON-UNION FRACTURES

On admission showed a swelling 5 centimetres square, corresponding to the window in the plaster, surrounding a shallow granulating area of small size over front of tibia. No gross pus. Tenderness only medial to the granulating area. There was a sinus in this granulating area leading down to bare bone. This discharged pus. Within three days the area of tenderness had become more marked and some redness developed. There was some attempt at callus formation, but bony union was absent and bone destruction was present.

X-ray studies of the left leg show an old comminuted fracture of the mid-portion of the tibia. There is considerable backward bowing of the tibia, as well as lateral bowing. A piece of the cortex is displaced away from the tibial shaft, and is separated from it toward the medial side. Several small fragments lie in the region of the fracture, and some of these are very dense, particularly one which is located on the anterior surface just underneath the soft tissue swelling. There is an attempt at callus formation on the posterior aspect of the tibia, and to some extent on the anterior. Along with this there is definite evidence of bone destruction. The findings represent an osteomyelitis at the point of an old compound fracture with sequestration.

October 22, Doctor Stimson made a 10-centimetre incision over the lower half of the crest of the tibia and elliptical piece of skin was removed including the area of two old sinuses. A small amount of pus exuded through one of the sinus openings as the skin was being removed. Incision deepened to bone and muscle and periosteum stripped from the tibia for about six inches. The old fracture site was easily identified, bone edges being united by dense fibrous tissue but with very little evidence of motion at the fracture site. Around this area the bone was soft and necrotic and there were greenish-yellowish spots of necrosis near it. The anterior cortex of the bone was chiseled away for about six inches. The resulting saucer had its deepest point at posterior cortex of the old site of fracture and became more shallow as it went away from it. Saucerization was continued until healthy bone was encountered throughout. No overhanging edges were left. The wound was packed wide open with vaseline gauze. A circular plaster splint from toes to mid-thigh applied over stockinet.

The pathologic report on the lunette specimen of bone removed was chronic suppurative osteomyelitis and fibrous union of fracture.

Six days after operation the vaseline gauze was removed, the wound surface rubbed to bleeding and the whole cavity up to the skin level filled with powdered sterilized calcium carbonate and triple phosphate in proportion of one to three. This was done through a window in the circular plaster.

The surface was then covered by vaseline gauze and the window replaced.

The saucerization was six inches in extent and in the region of the fracture site not much was left but the posterior cortex.

Seventeen days after placing the calcium, and twenty-three days post-operative, the plaster was removed and the leg dressed, a new circular plaster being applied. At this time the cavity was half filled by healthy granulation tissue, which showed areas of whitish and grayish discoloration due to calcium.

He was next dressed three weeks later at which time his wound was almost filled by granulation tissue of exceedingly firm character, which grated on section.

On January 3, 1931, a little over nine weeks after operation and eight weeks after calcium placement, the bone was clinically firm, his wound was completely filled by tissue and was epithelializing rapidly. X-ray on this date noted bony healing and no evidence of osteomyelitis. The circular plaster was removed and a posterior and sugar tongs of plaster below the knee were applied. On January 14, 1931, eleven weeks after the first operation, weight bearing in a brace was instituted. Since then he has had to have some surgical attention for skin healing, but bone has remained solidly healed with no further evidence of osteomyelitis. X-ray on February 14, 1931, shows bone production in the saucerized area, and the defect is largely obliterated by new bone.

NEW YORK SURGICAL SOCIETY

DELAYED AND NON-UNION IN FRACTURES IN THE ADULT

DR. CLAY RAY MURRAY then read a paper with the above title for which see page 961, vol. xciii, May, 1931.

DR. WILLIAM DARRACH said that this series of experimental investigations, both clinical and laboratory, is of special interest because it presents a different point of view. Previously, in trying to do something for these discouraging cases of delayed or non-union, the speaker had a mental picture of something that would bring the ends of the bone together so that the ends of the bones would heal. He now had a different point of view; that is, to bring the ends of the bone in such apposition that granulation tissue could form from the soft parts to form new bone. Doctor Darrach agreed with Doctor Murray that the source of new tissue which unites the ends of broken bones takes on the character of granulation tissue and goes into the stage of calcification and ossification. This point of view will probably effect considerable change in future technic. Some of Doctor Murray's cases have shown astonishing results. In the early stage of granulation tissue they present a picture of healthy red granulations but they are hard rather than soft. The way the cavity fills in is very encouraging. The only new thing about this treatment is the introduction of artificial calcium as a source for new bone formation, for the rest of the treatment is the same as the Orr treatment which is safe and sound if all the points are observed.

DR. SEWARD ERDMAN said that while the conception of new bone formation as brought out by Doctor Murray was interesting he could not see that it is the only way to bring about bony union. Two years ago, Doctor Pascal, of the Neckar Hospital in Paris, gave a talk at the French Hospital in which he showed some slides illustrating a method which he had found successful for fractures of the tibia. He used a metal collar from four to six inches wide which he placed about the fractured bone beginning just above the malleoli and reaching pretty well up the tibia. It took the place of external splints. According to Doctor Murray's theory, this should have deprived the bone of granulation tissue which is supposed to come from the muscle and yet Doctor Pascal reported prompt and astonishing results.

These metal collars of Pascal had some fenestrations—to permit fastening—as in the Parhan bands, but Dr. H. H. M. Lyle, who discussed the matter with Doctor Pascal, states that Pascal claimed the same good results when solid metal collars were used.

If this be true, Doctor Murray's theory would not appear to explain all cases.

DR. JOHN J. MOORHEAD remarked upon the apparent ease of obtaining union by the introduction of the calcium preparations. Other things had been used with the same idea in view, such as egg-shell and sea-shell. There were certain theoretical objections to the procedure because foreign bodies were introduced and in bone work particularly it had been found that auto-

DELAYED AND NON-UNION FRACTURES IN THE ADULT

genous material was almost a necessity. The speaker could not agree that the blood supply was not an important factor in non-union. Mention had been made of the common sites of non-union, among others the neck of the femur, and here the speaker was of the opinion that the basic factor as elsewhere was failure of coaptation. Recently they had been re-examining their stereoscopic X-rays and found that in a number of cases there was a falling away of the shaft from the neck indicating lack of coaptation and in effect a depressed fracture of the neck. One factor in the success of non-union was evidently a complete débridement which apparently was featured in the procedure presented.

DR. CONDUCT W. CUTLER, JR., considered it unwise to advocate routine primary operative reduction in fractures at sites where delayed union is apt to be common. He wondered whether Doctor Murray meant to advise, in every fracture of the lower tibia or the neck of the femur, for instance, the use of open reduction to avoid the possibility of delayed or non-union. In the opinion of the speaker, this presents potential danger of infection and introduces the factor of scar tissue. Scar tissue *per se* is not of advantage in local circulation or subsequent union. The treatment of infected non-union by the saucerization method is finding increasing favor and the introduction of calcium salts may well merit further investigation.

BRIEF COMMUNICATIONS

THE ABDUCTION METHOD CONSIDERED AS A STANDARD ROUTINE IN THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

Now that a method is at command which is adequate to assure the primary essentials of success, it has been demonstrated that union of the intracapsular fracture, once considered a remote possibility, may be attained in the majority of cases, the only debatable question being of percentage of the cases in which there is an actual incapacity for repair. The latest statistics compiled by Reggio give the results in forty-nine cases treated by the



FIG. 1.



FIG. 2.

FIG. 1.—A typical transcervical fracture.

FIG. 2.—Taken through the plaster showing the ineffective application of the abduction method. The prominent trochanter minor indicating outward rotation of the proximal fragment.

abduction method at the Massachusetts General Hospital. The patients were of an unfavorable type, 59 per cent. being over seventy years of age. Yet union was attained in 66 per cent. of the cases in which the treatment was carried to a conclusion. (*Journal of Bone and Joint Surgery*, October, 1930.)

This presents a striking contrast to the results recently reported from the Charity Hospital at Berlin of 136 cases treated by conventional methods in which there was union in but 6 per cent. (*Archiv. f. Orth. u. infall. Chir.*, May, 1930.)

Doctor Reggio, in comparing reports on the abduction treatment, finds it difficult to reconcile the discrepancies, bony union varying from 50 to 90 per cent. and the rate of mortality from 5 to 29 per cent. It would seem that the most reasonable explanations are the selection of cases and the relative efficiency of the treatment. Formerly transcervical fractures in

ABDUCTION FRACTURES NECK OF FEMUR

patients over seventy were not treated and the prospect of repair at this age is manifestly less favorable than in middle life. Furthermore, in view of the small area of the fragments and the dependence of repair on accurate opposition, it will appear that technical skill and experience must be the determining factor of the result. A new treatment must be undertaken by novices and although this test has demonstrated its practicability and efficiency in a relative sense, its application as far as one may judge from personal observation leaves much to be desired.

Of this the accompanying X-ray pictures will serve as examples:

It may be noted that the discussions on treatment of this injury have been concerned only with the transcervical fracture. This may be explained by the fact that, formerly, success or failure was determined by union or non-



FIG. 3.

FIG. 3.—Re-application of the treatment illustrating the apposition of the fragments.



FIG. 4.

FIG. 4.—Bony repair.

union, function receiving no consideration whatever. Fractures at the base of the neck were therefore of little interest, since in the words of an authority: "They get well anyhow under good or bad treatment." Getting well in this sense implied only the capacity for weight bearing, functional disability, evidenced by a limp, being accepted as an inevitable sequel of the injury. The abduction treatment is in accord with surgical principles and comprehensive in its scope. Since, therefore, all cases are treated with the same purpose and by the same method, fracture at the hip has now become an entity in the sense that the old distinctions of type, which once ostensibly determined the character of the treatment, are no longer of any immediate therapeutic importance.

As a treatment of fracture, the technical superiority of the abduction method is so obvious that one must conclude with Mosenthal that the real obstacle to its general adoption is inability to meet its requirements. (Med. Klinik, vol. x, 1929.) The question at issue, therefore, is of standard, for

when it is officially conceded that fracture at the hip is amenable to the rules that govern the treatment of other fractures and entitled therefore to the same protection, there can be no alternative to the treatment that has made the common standard practicable. For with this means at command one who cannot present evidence that he has made success possible will be held responsible for failure.

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BASAL CELL CARCINOMA OF THE PENIS*

IN A recent study of fifty cases of *epidermoid* carcinoma of the penis, Colby and Smith (Jour. Urology, vol. xxv, No. 5, p. 46) divided them, according to their histologic appearance and clinical course, into groups of low and high degrees of malignancy. They found that at least half of them

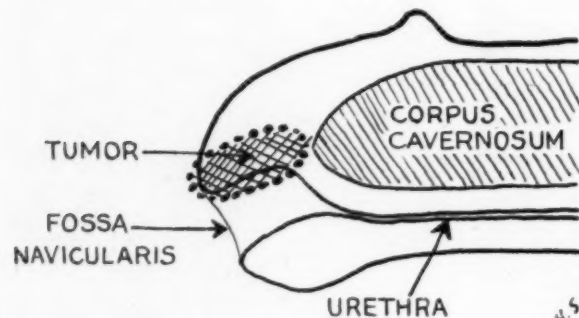


FIG. 1.

(26) belonged to the former group while the remainder (24) belonged to the latter. Basal cell carcinoma of the penis is so rare that a cursory examination of the literature and a consultation with two capable pathologists has failed to reveal the record of a case of the relatively non-malignant type of tumor (so located), which is described in the following case:

September 23, 1925, a sixty-seven-year-old man came to me complaining of a small lump near the end of his penis. He was of the lean type, apparently in good health and had no other complaints. There was no loss of weight. His past history is irrelevant. He had noticed the lump about nine weeks before I first saw him. Examination of the penis by inspection revealed very little. There was a very slight bulge outward just above the meatus and on separating the lips of the meatus a slight bulging in of the roof of the urethra could be detected. But apart from a slightly granular appearance of the glans and the urethral mucosa over the bulging part, the glans and urethra appeared to be normal. On palpation of the glans, however, one could distinctly outline more or less definitely an elongated mass which apparently was shaped like a jelly bean. It was about $1\frac{1}{2}$ centimetres long and a little over $\frac{1}{2}$ centimetre in its transverse diameter. It did not feel hard but was firm enough to permit of definite palpation and seemed to lie on top of the urethra and run more or less parallel to it. (Fig. 1.)

Under local anaesthesia a small piece of the lesion, including a little bit of the meatus, was removed for microscopic examination. The specimen was examined in the Cornell Medical College laboratory by Doctors Ewing and Smith who reported it to be a basal cell carcinoma, clinically non-malignant. (Figs. 2 and 3.)

Since this is the type of neoplastic growth that usually responds well to radium, radium therapy was decided upon. October 18, 1929, a gold seed containing 1 millicuries of radium emanation was implanted into the growth. I attempted to place this seed as near the centre of the mass as possible. About two weeks later the patient was seen

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*Read at a meeting of the American Association of Genito-Urinary Surgeons, June 4, 1931.

CARCINOMA OF PENIS

again and there was no apparent change in his condition. Five weeks after the implantation of the radium, the lesion appeared to be a little bit softer but of this I could not feel sure.

January 17, 1930, three months after the radium was implanted, there was apparently no change at all in the lesion. Therefore another gold seed, this one containing $1\frac{1}{2}$ millicuries of radium was implanted and likewise as near the centre of the growth as possible.

The patient was next seen April 25, 1930, or a little over three months after the second radium seed was implanted. Again there was apparently no change. At this time another gold seed of $1\frac{1}{2}$ millicuries of radium was implanted.

The next examination of the patient on June 18, 1930, or seven weeks after the third implantation of radium, showed possibly a little softening of the tumor mass but again I could not feel sure of this. No other change was apparent. For the fourth time, therefore, another radium seed was placed within the growth. The last one also contained $1\frac{1}{2}$ millicuries of radium emanation. October 8, 1930, or approximately four months after the fourth radium implantation, the lesion had disappeared. There was no



FIG. 2.



FIG. 3.

FIG. 2.—Low power showing extent of tumor, sharply delimited. No invasion by the tumor cells.
FIG. 3.—High power showing basal cells (not squamous) arranged in trabeculae. Note sharp line of demarcation, also uniformity of staining and of size of cells.

external evidence of anything abnormal and only the slightest amount of induration could be felt at the site of the growth.

The patient was last seen December 23, 1930, at which time there was no evidence at all of the former lesion.

March 25, 1931, a letter received from the patient's physician, a very reliable and painstaking man, stated that there was still no evidence of the former growth and that in case it should reappear he would let me hear from him. So far I have received no further communication and therefore consider no news good news.

A puzzling feature of this case to me was why the radium apparently did not act more promptly. In searching about for an explanation of this, it was suggested that possibly some of the seeds might have dropped out fairly soon after having been implanted. Therefore on his visit of October 8, an X-ray was made which showed only one gold-seed shadow. This seemed to confirm, at least to some extent, the idea that the other seeds did not remain sufficiently long to permit the radium to act upon the tissue.

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STRANGULATED FEMORAL HERNIA OF FALLOPIAN TUBE

It is very rare that the Fallopian tube escapes through the femoral canal into the sac. The tubes as a rule are on a lower level than the femoral opening. The following case therefore is worthy of record:

CASE REPORT.—Mrs. A. H., fifty, married, four children, normal deliveries. Previous history negative except for metrorrhagia for past few years. Patient was diagnosed to have a bleeding fibroid uterus. Four days prior to admission to hospital for removal, the patient noticed for the first time a mass in the right femoral region about the size of a small tangerine which gradually increased in size to that of a large orange. She complained of pain and tenderness in the region of the mass. She was admitted to the United Israel-Zion Hospital on March 30, 1931. When admitted there was a mass about the size of a large fist in the right inguinal region, quite tense, tender, skin freely movable over it, fixed to underlying structures, no impulse on coughing, irreducible and flat on percussion. Vaginal examination revealed the uterus to be about three times its normal size, somewhat tender, pulled over and fixed to the right. From the general appearance of the mass one would make the diagnosis of a strangulated femoral hernia, which most often contains small intestine.

Under spinal anaesthesia the sac was exposed. It was about the size of a large fist, of dark plum color; it was dissected down to its neck which was found to be right underneath Poupart's ligament and firmly constricted at the site of the femoral ring. As the sac was incised there was an escape of about half a glass of bloody fluid. In the sac was found a swollen oedematous tubular mass about the size of a frankfurter sausage. Its distal end was rounded and club shaped, and its proximal end was constricted at the neck of the sac. At first sight it appeared like a small intestine but it only had one limb of a loop; on close examination it proved to be a strangulated oedematous right Fallopian tube.

The mass could not be reduced with the same ease as strangulated small intestine as it was practically a solid tumor mass with its diameter much larger than the opening of the femoral canal. A salpingectomy was accordingly done. This was readily accomplished by pulling on the tube and its mesosalpinx until the cornu of the uterus could be felt with the finger. When the tube, which corked the femoral canal, was removed, a large amount of bloody fluid escaped from the peritoneal cavity, apparently due to some impaired circulation of the broad ligament and right ovary. The sac was quite thick and oedematous. On its outer surface was a thick layer of pendulous, polypoid, preperitoneal fat. It was dealt with as an ordinary femoral hernia, ligating the sac at its neck, high up, and removing it. The under surface of Poupart's ligament was then sutured to the pectinæus muscle and fascia with interrupted chromic No. 2, thus obliterating the femoral canal.

A hysterectomy was then proceeded with. This was done through the original skin and fascial hernial incision. These tissues were retracted toward the mid-line and the right rectus sheath with the peritoneum were then incised. More bloody fluid escaped. The abdominal cavity was explored. The uterus was found to have a good-sized fibroid in its body and small fibroids in its cervical portion. One could then also see the ligated stump of the right tube and the ligated neck of the sac pulled upwards away from the femoral canal. With no difficulty a complete hysterectomy was done including both ovaries, left tube, and cervix. The entire procedure, the salpingectomy, hernioplasty, and hysterectomy, with complete closure, lasted thirty minutes.

The patient had a very satisfactory convalescence. The wound healed by primary union. Looking at the scar, which is typical for a hernioplasty, one has to stretch his imagination to believe that a hysterectomy was performed through such an incision.

EVACUATION OF DEEP-SEATED ABSCESES

The patient was up and about in twelve days and was discharged as cured two weeks following the operation.

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GOITRE RETRACTOR

A GOOD exposure is one of the important factors in goitre surgery. There are a number of retractors devised for use in goitre operations, but some are inapplicable for all cases to give good exposure and remain in position.

The retractor shown in the illustration seems best adapted to most cases and incisions. It not only remains "put" when set in position but gives splendid exposure.

The instrument measures fifteen inches over all. The central section is four inches long and each lateral section five and a half inches in length. There are two sets of three prongs each on the upper and lower portion of the spreader with a distance of one inch between the bases of the central

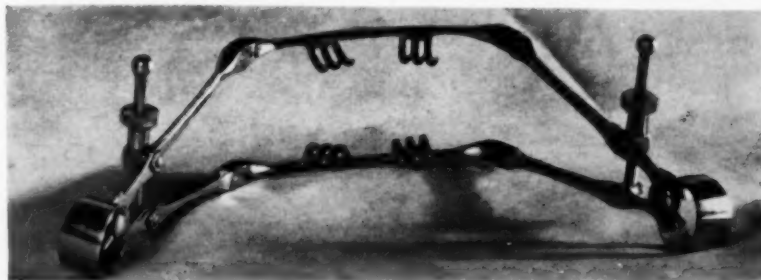


FIG. 1.—Goitre retractor.

prongs. There are four double-action joints, one at each end of the two central sections, allowing for marked adjustability of the lateral sections. There are two single self-locking devices, one at the junction of the middle and distal thirds of each lateral section. At each end of the retractor is one unit of a coil type of spring. The retractor has a spreading distance of four and a half inches. Having the retractor the same at each end balances it and there is no difficulty of its getting out of position. (Fig. 1.)

After cutting the ribbon muscles across, if this is desirable, the prongs may be set under the turned up muscle and thus increase the exposure.

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THE EVACUATION OF DEEP-SEATED ABSCESES*

IN THE surgical drainage of a deep-seated abscess such as may be encountered in the lung or liver, the following procedure is commonly employed:

- I. Introduction of aspirating needle to locate the abscess cavity.

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BRIEF COMMUNICATIONS

2. Introduction of grooved-director alongside of the needle. Withdrawal of the needle.
3. Introduction of blunt dressing forceps alongside of grooved-director to spread open the tract.
4. Enlargement of tract to the desired width by means of a knife.

The following features of this procedure are objectionable:

1. In introducing the grooved-director alongside of the aspirating needle after the cavity has been located, the surgeon often misses the cavity because he introduces the instrument for either too great or too short a distance.
2. The conventional blunt grooved-director produces considerable trauma by tearing through indurated tissue when introduced. This is particularly true when dealing with inflamed pulmonary tissue.
3. The blunt dressing forceps produces similar trauma when introduced, and especially when the blades are spread to tear open the tract more widely.
4. The procedure, if carefully done, consumes considerable time.

In order to obviate the above-mentioned difficulties, a simple set of instruments which has simplified and rendered the procedure more precise, was devised. The set consists of:

1. Aspirating needles which are calibrated in centimetres.
2. A grooved-director similarly calibrated and bearing a sharp-cutting point.
3. A special pair of scissors which resembles an ordinary sharp-pointed, long-bladed pair, with the exception that the back of each blade is ground down to a fine cutting edge. One blade and shank are calibrated in centimetres.

In opening a deep-seated abscess with this set of instruments, the procedure consists of locating the cavity in the usual manner with the aspirating needle, at the same time noting the depth at which pus is encountered. This depth is readily visible on the calibrated needle. The calibrated sharp-pointed cutting grooved-director is then readily introduced alongside of the needle, for exactly the same distance, thus making sure that the tip of the grooved-director lies in the abscess cavity. The aspirating needle is then removed. Next, the special pair of scissors is introduced alongside of the grooved-director for the desired distance as noted on the calibrations, and the blades are opened. The scissors are then withdrawn, holding the blades firmly in the opened position. This manoeuvre enables the surgeon to open the cavity as widely as is desired, as the cutting edge on the back of each blade acts as a knife. By opening the blades to the desired position, a drainage tract of any given diameter can be readily produced.

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EVACUATION OF DEEP-SEATED ABSCESSES

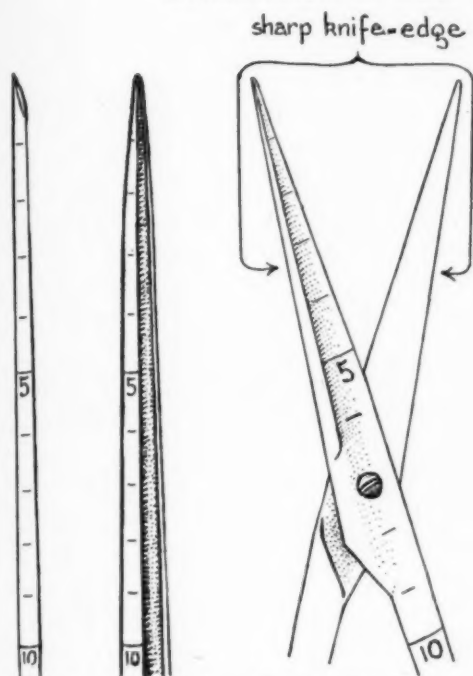


FIG. 1.—Enlarged view of tips of instruments.

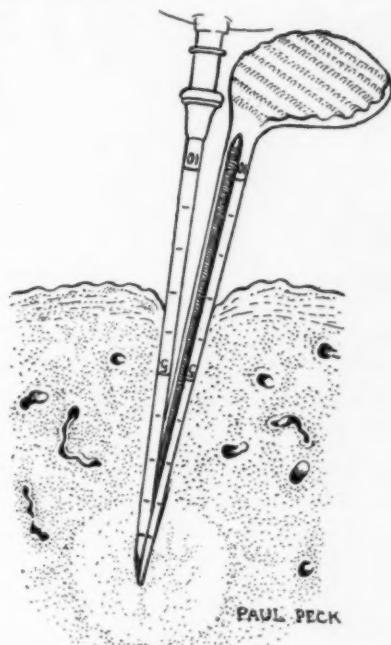


FIG. 2.—(Steps 1 and 2). Aspirating needle has located pus at depth X. Grooved director is then introduced for distance X.

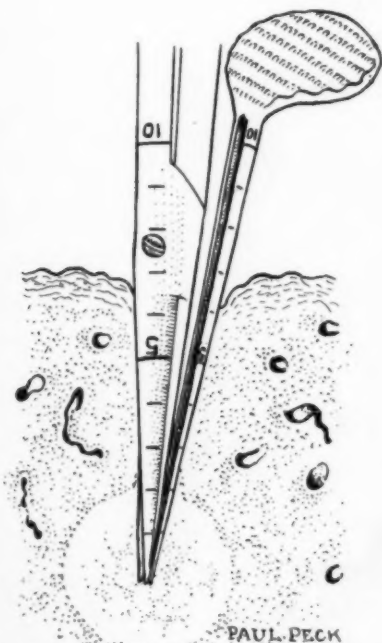


FIG. 3.—(Step 3). Aspirating needle has been withdrawn, leaving grooved director in place. Special knife-scissors is then introduced for distance X.

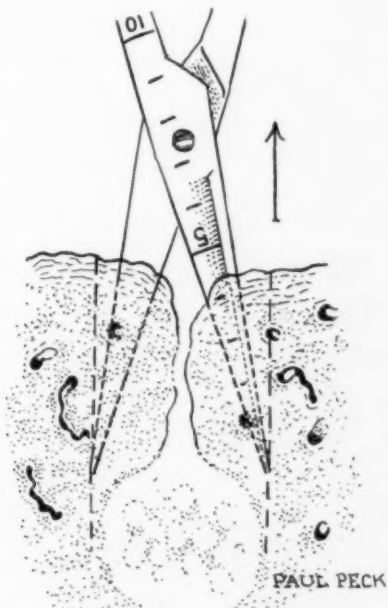


FIG. 4.—(Step 4). Knife-scissors is being withdrawn with blades open, thus creating a wide drainage tract.

BOOK REVIEW

COLLECTED PAPERS, 1904 to 1929, by EDWIN BEER, M.D. 8 vo.; cloth; 838 pp. Paul B. Hoeber, New York, 1931.

Here is a book of over 800 pages, containing ninety different papers, upon various subjects, which record some of the work of a single New York surgeon during twenty-five years. It is evident that the author has been in the midst of an active and progressive surgical period, the experiences of which and the results accomplished during which have been the subject of constant study.

We have therefore in this book a reflection of the intense activity and the progressive nature of the surgical world during the first quarter of the twentieth century—a period built upon antiseptics, varied processes of anæsthesia, and constantly developing knowledge of physiology.

The book therefore may well serve as an introduction to the accomplishments of the surgery of the twentieth century. As one reflects upon its character, one cannot help being struck by the importance of the foundations established by the work of such men as Morton and Simpson in general anæsthesia, Lister and the surgeons of the '80's in antiseptics, and Koller and Labat and their associates in local anæsthesia, and the many enthusiastic laborers in physiologic and pathologic laboratories from Virchow and Claude Bernard during the last half of the century, upon which the accomplishments of the surgeons of the twentieth century are based. Doctor Beer's work belongs to the twentieth century. His papers are grouped under various heads, such as gastro-intestinal subjects, the liver, the genito-urinary system (which includes by far the greater number of papers), with papers on the spleen and on the spinal cord, and a few miscellaneous papers.

While many of these are brief, there are some of comprehensive character and of lasting value. We note particularly the three papers, making forty pages, devoted to the urinary organs of children; several papers on bladder tumors, aggregating sixty pages in all. A paper on total cystectomy for cancer should not be overlooked, and also one on functional renal tests. The therapeutic value of artificial hyperæmia is the subject of extended treatment.

The volume as a whole presents a valuable picture of the possible activities in the domain of surgery which the present-day offers to an active and enthusiastic worker in its fields. The example of Doctor Beer in thus collecting and presenting his work is to be commended to the imitation of his colleagues.

LEWIS S. PILCHER.

EDITORIAL ADDRESS

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